A COMPUTER BASED TEACHING AID

FOR SOME CORE ASPECTS OF

MONEY IN THE ECONOMY

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ABSTRACT

A Computer-based Teaching Aid for Some Core Aspects of Money in the Economy

By Ian J. Shepherd

This dissertation develops an electronic model covering some core aspects of money and banking. It examines fractional reserve banking from the perspective of the U.S. Central Bank. Short-run effects of money supply changes are examined. The model gauges the impact of money supply changes on inflation, using the equation of exchange. A portfolio balance approach is used to model the impact of money supply changes on interest rates. The model distinguishes between long-run and short-run interest rates based on the expectations theory of the term structure of interest rates. Interest rate changes affect the exchange rate via uncovered interest rate parity. The impact of money on the real economy is modeled through changes in inflation, interest rates, and exchange rates. The model is developed in Microsoft's Excel product. The spreadsheet is designed to allow the user to step through the money creation process at a controlled pace. Different scenarios are examined, demonstrating both functionality and application within the classroom.

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CHAPTER 1

Introduction

In the past, chalk and blackboard were the media of transmitting knowledge. Textbooks with dated information were often the bases for classes. Today, new "electronic tools" are available to the classroom instructor. These tools allow the design and use of electronic models to present economic theories in a new way.

The Internet has made available to all teachers access to large quantities of current data and real-world examples of relevance to economics. It is a resource that offers a new source of information gathering that can assist in classroom instruction and student research. It has also become an important tool for conferencing and data retrieval (Agarwal and Day, 1998).

The Internet represents a revolution in the classroom and in teaching methodologies. It promotes interaction between students and teachers (both near and far) and fosters new methods of research. The application of this information through interactive models is a new and exciting way of teaching economics. In some cases, on-line textbooks have in essence become "living texts" as lecturers update and broaden topics and articles for student consumption. These living texts contain writing, as did the regular textbook, but also allow the use of models, spreadsheets and graphics, giving the user the ability to interact with the subject matter. The limitations of the past (the "paper-driven learning system") are being broken down.

The computerization of universities in recent years has given both teachers and students the ability to develop critical skills in data manipulation and management at the personal level. Software has become increasingly user friendly, allowing even the most modest user the ability to create and design simple documents and spreadsheets. While the tools are now available for teachers to create these living texts and design these models, time, and user skills are often limited (Agarwal and Day, 1996).

Why, in the past, has computer-aided instruction in economics not been particularly successful? Schenk and Silvia (1984) found that computer aided instruction (CAI[1]) often failed, not because of the method, but because computer materials were poorly developed. The article points out that even if computer materials were of good quality, they were often poorly used. The article suggests that the computer "does allow complex calculations which may open up other subject matters that are difficult to approach in the classroom."   The task of the instructor is to understand and use these teaching tools in ways that help the learning process rather than hinder it.

While some think that CAI is still not worth the effort, others disagree. Dalgaard, Lewis, and Boyer (1984) suggest that CAI has the following beneficial effects:

- Computer-Based teaching can be effective in raising student achievement. Eighty percent of studies reviewed by the author showed that CAI students outperformed other students in control groups.

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[1] Siegfried and Fels (1979) defined CAI as the use of the computer as a tutorial teaching machine, able to respond with individualized help to a student in difficulty.

- CAI can reduce the average training time of students by permitting and encouraging each student to move at his or her own pace. CAI reduces the time required for a subject by twenty five to fifty percent while still resulting in the same end performance.

- Student attitudes toward the subject being learned and student ratings of the quality of instruction tend to be slightly more favorable in CAI.

- Students tend to have a positive attitude toward CAI, frequently accompanied by increased motivation, attention span, and class attendance.

- CAI may increase labor productivity in the teaching / learning process.

The transition from tried and true teaching practices to new teaching methods is not easy for both the teacher and student. Corporations expect computer literacy and analytical skills from graduates entering the workforce. Graduates are required as they enter industry to be skilled in the use of these new business tools. Instructors, by default, must prepare the student to use these new tools through their inclusion in core teaching areas.

The intent of this dissertation is to develop a model that can be used in introductory and intermediate macroeconomics classes to convey to students some key aspects of how money is created and how money is affecting the economy. The model is designed to fulfill two purposes: first, to teach economic theory in a practical way; and second, to familiarize the student with these new tools. The money and banking theme was chosen because it is a core aspect throughout the economics regimen at any college

or university. Therefore, the model has the potential to be of use in more than one course. In fact, it has the potential to be useful for money themes taught at all levels.

This electronic model helps move the student and teacher away from complex and detailed stand-alone models that are usually found in the economics regimen. Stand-alone models limit the student's reasoning ability. By design, this model focuses on relationships and interactions between different sectors of the model, giving the student the ability to think outside the defined scope of a given problem.

Siegfried, Bartlett, Hansen, Kelley, McCloskey, and Tietenberg (1991) suggest that any model should develop decision-making techniques and should offer perspective on how choices are made and on what the consequences of those choices will be. This orientation will help the student economist to:

- Examine tradeoffs by comparing alternatives

- Measure the costs of one choice in terms of the foregone benefits of another (opportunity cost)

- Understand formulations involving constrained maximization

- Determine issues relating to efficiency or getting the most out of limited resources

The economics curriculum often focuses on a broad spectrum of requirements. Introductory courses offer discussion on principles and methods available to the economist. Intermediate courses develop the basic theory of macro and apply analytical techniques, which allow the student to broaden his or her understanding of the discipline. The goal of this electronic model is to help the student understand relationships and

develop the skills needed to function within the major area of study. The model offers a link between the different levels of understanding and the requirements at each level (Erekson, Raynold, Salemi, 1996).

The model can be divided into two different levels of instruction. The introductory level focuses on the fractional banking system and shows the money transmission process through the Federal Reserve's (Fed's) interaction with regional banks and the lending process. The equation of exchange is used to model inflation. The intermediate level develops the impact of money on exchange and interest rates as well as on the components of aggregate demand.

The intention of the model is that it be used as a teaching tool. (While it has been designed as a teaching tool, the teacher may also use it to assign supplemental work to the student.) The model is intended to be simple enough for each student to model different situations pertaining to money and the economy. The ability of the model to be used in this way adds another dimension to the regular classroom teaching methodology.

Effective learning requires active participation by students. The more practical the learning experience, the more the lesson is learned. The ability to link the processes of the monetary system to step-by-step controls puts the students in control of the speed with which they proceed through the learning process. The ability to give the students control over the rate of learning enhances retention of the material.

The Commission on Graduate Education in Economics (Krueger et al., 1991) recommended the need for "more courses, and more content in existing courses, that apply and use theory." They recommended that more courses should mediate between

the theoretical and empirical realms in a manner that benefits both. The goal of this model is to allow the student to join theory with the practical application of money in the economy.

CHAPTER 2

The Model

2.1.1. Model Overview

The model simulates the transmission of money through the economy. The impact that this transmission process has on the economy is examined from a short-run perspective. In the classical and most of the neo-classical world, money has only a temporary impact on the real sector. In the long-run, money only changes absolute prices - the equation of exchange is at work. In this model, we consider only the short-run effect - the change to aggregate demand. The change in aggregate demand is equal to the change in output in the very short-run as long as prices are constant (as long as the aggregate supply curve is horizontal). This scenario is not valid if one assumes an economy with high inflation rates that is operating at full capacity. Prices tend to react quickly in that type of environment, much more quickly than do quantities.

The model is designed around an independent central bank relying largely on open-market operations, reflecting the reality of the U.S. economy and that of most other industrialized countries. The model is, however, general enough to handle other monetary arrangements, such as a currency board system or a system based on gold (or some other commodity). While these alternative monetary arrangements can be brought to life without much additional work, the focus of this dissertation remains on open-market operations by the Fed.

The Fed can take one of two basic approaches to affect reserves. First, it can target a certain quantity of reserves, allowing changes in the demand for reserves to influence the federal funds rate. Second, it can target the price of reserves (the federal funds rate) by adjusting the supply of reserves to meet any change in demand of reserves. Recent actions by the Fed have focused mainly on adjusting the price of reserves. In general, no one approach to implementing monetary policy is likely to be satisfactory under all conditions. This model uses the first approach when modeling monetary policy. The targeting of a certain quantity of reserves is the method most often used in classroom textbooks today.

The impact of money is modeled via changes in inflation, interest rates, and exchange rates. To keep the analysis simple, a *two-asset* world is assumed. Financial assets are in the form of money or bonds.

Figure 1 sets out a high level overview of the model. The file can be accessed directly by clicking on the following link: (map.pdf). The model is developed in terms of percentage changes, not absolute changes. These percentage changes are denoted by **^** throughout this document. This map shows money (*M1*) driving the model as changes are made in the fractional reserve banking system and as individuals change their cash holding preferences. The interaction of money and bonds determines the short-run interest rate in this *two-asset* model. The expectations theory of the term structure of interest rates is used to determine the long-run interest rate. Uncovered interest rate parity drives the nominal exchange rate. The real exchange rate is driven by the nominal exchange rate and the difference between the expected domestic inflation rate and the

foreign inflation rate. The model determines changes in aggregate demand (*Y*) using changes that occur in: consumption (*C*), investment (*I*), government spending (*G*), exports (*X*), and imports (*M*).

To allow easy use within the classroom, the model is presented in both written and PDF[2] formats. Throughout both these documents are direct links to Microsoft Excel spreadsheets[3] (available through hyperlinks in the document) and relevant Internet sites.

Reference is made to Internet sites for additional information. These sites are used as:

- sources of current economic data: such as economic indicators (http://www.globalexposure.com/index.html) and government statistics (http://stats.bls.gov/datahome.htm)

- additional resources to explain government's role in the economy: (http://www.bog.frb.fed.us/)

- sources of information on banking research (http://www.bog.frb.fed.us/pubs/workingpapers.htm)

- sources of general information (Http://econwpa.wustl.edu/EconFAQ/EconFAQ.html)

- sources of international information (http://www.bog.frb.fed.us/centralbanks.htm)

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[2] PDF – is defined as "Printer Definition File" and is a universal file format that can be downloaded and printed by any PC. The PDF file makes use of a "Reader" that is distributed free over the Internet. Products such as Adobe Acrobat allow the creation of PDF files by selecting "Print to PDF" rather than a printer. Free PDF readers are available from the web site www.adobeacrobat.com.

[3] Microsoft Excel is a software package available to most students today through Microsoft's Office Suite of products.

Appendix A contains a listing of hyperlinks that are used throughout this dissertation.

The model is designed so that the student or teacher will be able to enter variables (within certain ranges) and view step by step transactions through the money creation process. Explanations of each transaction appear at the completion of each step.

2.1.2. Acknowledgement

The empirical model used in this dissertation is adapted from a model originally developed by Dr. Joachim Zietz for teaching purposes at Middle Tennessee State University.

2.1.3. Document Format

This document is filled with many tables and figures explaining the models application. Where practicable, new topics have been started on a new page to allow the user to read descriptions, view figures, and refer to tables in an easy way. While practical, it makes the format of the document appear more as a training manual than a dissertation. Consideration had to be given to the user when formatting the document as the stated purpose is to design and develop a model for use in the classroom.

Figure 1 - Model Flow Diagram

Central Bank
- Reserve Requirements
- Open Market Transactions

Banking System
- Voluntary Excess Reserves

Public
-Cash Held

MB = Monetary Base

M1 = Money Supply

Equation of Exchange

$M1 \times V = P \times Y$

Convert to Percent Change Form

$\hat{M1} \times \hat{V} = \hat{P} \times \hat{Y}$

Assumed $\hat{Y}$

$\hat{V}$

Portfolio Balance Approach (2 Asset World)

Wealth = M1 + Bonds

Expected Inflation

Short run nominal interest rate: i

Consumption $(\hat{C})$

Expected short run interest rate:
$i_{exp} = i + $ (expected inflation - actual inflation)

Long run interest rate (expectations theory)
$i_l = (((1 + i)\ (1+i_{exp})^{n-1})^{1/n})-1$

Government $\hat{}$
Spending $(\hat{G})$

Real long run interest rate:
$r_l = i_l$ - expected inflation

Investment $(\hat{I})$

Foreign Influence

Uncovered Interest Rate Parity (UIP)
$i = i_{foreign} + \hat{e}$ (expected depreciation)

Foreign Income Growth

Real Exchange Rate
$\hat{e}_{real} = -\hat{e} - $ foreign inflation $+ \hat{p}$

Exports $(\hat{X})$

Imports $(\hat{M})$

Phillip's Curve Inflation
$\hat{P}_{new} = h(\hat{Yd} - \hat{Y}) + (k\ \hat{p}_{exp} - (1-k)\ \hat{p}) + rr$

2.2. Theoretical Background

The development and use of the model by students requires a basic understanding of money and its effect on the economy. The following sections describe briefly the background and principles involved in the monetary system discussed throughout the model.

2.2.1. Monetary Authority

The United States has as its monetary authority a central bank (The Federal Reserve – Fed). The Fed is an institution created by legislation of the U.S. government to oversee monetary policy and the banking system.

The Federal Reserve System in the U.S. is comprised of several entities charged with running the monetary system. System functions of the Fed are carried out by twelve Fed banks and twenty-five Fed branches. They operate the payment systems, distribute currency, supervise banks, and serve as the bank for the U.S. Treasury. Each of the twelve Federal Reserve Banks is located in one of the larger financial markets. Their main functions are to:

- clear checks

- issue new currency

- withdraw old currency

- evaluate bank mergers

- administer and make loans to banks in their district

- act as liaison between the business community and the Fed

- conduct research related to monetary policy

These twelve banks are involved in monetary policy in the following ways:

- they establish the discount rate (which is reviewed by the Board of Governors)

- they decide which banks obtain discount loans from the Fed

- they select a commercial banker to serve on the Federal Advisory Council

- five bank presidents serve in the Open Market Operating Committee

The Fed plays an important role in the U.S. economy:

- it conducts the monetary policy of the nation by changing the monetary base and the Discount Rate to control unemployment and maintain stable prices

- it supervises and regulates banks to ensure the safety of the nation's banking system and protect the rights of banking consumers

- it works at controlling risk in the financial markets by maintaining the stability of the financial system

- it provides financial services to the Government, public institutions, financial institutions, and foreign institutions by providing a conduit for the nation's payment systems

The Board of Governors is a group of seven members that head the Federal Reserve System. All of these Governors are members of the Federal Open Market Committee. Their functions are to:

- be actively involved with decisions concerning the conduct of monetary policy

- set reserve requirements (within limits set by legislation)

- control the discount rate through the "review and approval" process

- advise the president on economic policy (usually the chairman's task)

The Federal Advisory Council consults with the Board of Governors and makes recommendations on the conduct of monetary policy. They discuss economic and banking matters and consumer credit protection, and provide information to the Board of Governors on thrift banking matters.

The Federal Reserve System is also made up of member and non-member commercial banks. All national banks that are chartered by the Office of the Comptroller of the Currency are required to be members of the Federal Reserve System. In 1987, all banks became subject to Fed requirements placing all member and non-member banks on a similar footing.

The FOMC makes decisions regarding the conduct of open-market operations. The members meet every six weeks to determine what actions need to be taken with regard to monetary policy. They instruct the trading desk at the Federal Reserve Bank in New York to make purchases and sales of government securities. The FOMC is the focal point of the Federal Reserve System. It is here that policy is implemented.[4]

2.2.2. Money Creation and the Money Multiplier

While the Fed controls the monetary base, uncontrollable factors influence the outcome of the Fed's open-market transactions in terms of the money supply. The money supply is determined, not only by the Fed's intervention in the securities market, but also by the actions of economic agents. This effect can be seen by examining the

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[4] For a more comprehensive discussion of the Fed, you can go to http://www.bog.frb.fed.us/ where the structure, actions, and responsibilities are more fully discussed.

components of the money multiplier. To determine the money multiplier, the money supply ($M1$) is defined as:

(1) $M1 = C + DD$

where C is defined as currency, and DD as demand deposits.

The Fed has direct control of the monetary base (MB) which is given as the total of currency (C) and bank reserves (RR). Monetary base (MB) is also known under the name of high-powered or outside-money (this is money that is created outside the commercial banking system). Money that is created through the loan process of banks is called inside-money (money created inside the commercial banking system).

In a fractional reserve banking system, banks are required to hold a fraction of their deposits in reserve at the Fed. A rise in required reserve deposits (rr) reduces the amount of loans that would normally be created through the loan creation process of banks. This leads to a contraction of the money supply. A drop in required reserve deposit requirements increases the amount of loans created through the banking system. This expands the money supply.

The currency deposit ratio (C/DD) represents the amount of currency that people hold to cover their own needs. This ratio is calculated as a percent of people's demand deposits. Banks may hold excess reserves (ER). These are reserves over the minimum required by the Fed and are calculated as a percentage of demand deposits (ER/DD).

Given the money supply ($M1$) definition in equation (1), the relationship to the monetary base, reserve deposit ratio, excess reserves, and currency deposit ratio can be

examined. The monetary base (*MB*) is defined as the sum of currency (*C*), reserves (*RR*), and excess reserves (*ER*).

(2) $MB = C + RR + ER$

To solve for money supply (*M*1) as a function of currency (*C*), demand deposits (*DD*), required reserves (*RR*), and excess reserves (*ER*) equation (1) is divided by equation (2)

(3) $(M1 / MB) = (C + DD) / (C + RR + ER)$

By dividing both the top and bottom of the right hand side of the equation by demand deposits (*DD*), it is possible to see how the currency deposit ratio (*cr*), reserve deposit ratio (*rr*), and excess reserve ratio (*er*) are formed.

(4) $(M1 / MB) = (C / DD + DD / DD) / (C / DD + RR / DD + ER / DD)$

Currency divided by demand deposits (*C/DD*) represents the currency deposit ratio (*cr*). Required reserves divided by demand deposits (*RR/DD*) are the reserve deposit ratio (*rr*). Similarly, excess reserves divided by demand deposits (*ER/DD*) are the excess reserve deposit ratio (*er*). Substituting the abbreviations for the currency deposit ratio, reserve deposit ratio, and excess reserve deposit ratio into equation (4) the formula can be restated as

(5) $M1 = (cr + 1) / (cr + rr + er) \, MB$

Equation (5) implies that the money supply (*M*1) is proportional to the monetary base (*MB*). The relationship between the money supply and the monetary base is called the money multiplier (*m*).

(6) $m = (cr + 1) / (cr + rr + er)$

Combining equations (5) and (6) restates the formula as

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(7) $M1 = m\ MB$

Equation (7) shows how each dollar of the monetary base (*MB*) produces "*m*" multiples of the monetary base, giving the total money supply (*M*1). If the Fed changes the monetary base (*MB*) by a certain percentage, then the money supply will increase by that same percentage (assuming no change in the currency deposit ratio (*cr*), excess reserves (*er*), or the required reserve ratio (*rr*)). The lower the reserve deposit ratio (*rr*), the more loans banks can make. Finally, the lower the currency-deposit ratio (*cr*), and the excess reserve ratio (*er*), the fewer dollars are held out of the money creation process. In both these cases, the money supply increases.

The Fed changes the monetary base by making purchases or sales of government bonds through open-market transactions. The sale of bonds by the Fed reduces the monetary base. Alternatively, the purchase of bonds on the open-market increases the monetary base.

The Fed is able to make loans to banks when the banks face temporary, unforeseen changes in their asset-liability structure. The rate that the Fed charges for these loans is called the discount rate. The lower the discount rate, the less borrowing from the Fed costs, and the more likely a bank will be to borrow. Discount loans affect the monetary base. A loan from the Fed to a bank increases the monetary base. Alternatively, when a bank repays a discount loan to the Fed, the resulting payment reduces the monetary base.

2.2.3. Inflation and the Equation of Exchange

The quantity theory of money as discussed by Irving Fisher (1911) links long-run inflation to the money supply ($M1$). Fisher examines the link between money supply ($M1$) and the total amount of spending on finished goods and services (PY) where P is the price level and Y is aggregate output. Total spending (PY) is equivalent to GDP. The concept that provides the link between the money supply ($M1$) and total output (PY) is called the velocity of money. Velocity (V) can be defined as total output (PY) divided by the money supply ($M1$)

(8) $V = (PY \, / \, M1)$

To illustrate this relationship, one might suppose that the nominal GDP (PY) in a year is $6 trillion and the quantity of the money supply ($M1$) is $1 trillion. This implies that velocity is six, meaning that the average dollar changes hands six times while purchasing final goods and services within the economy.

Fisher reasoned that the velocity of money is determined mainly by the institutions in the economy that allow individuals to make transactions. The use of credit cards and charge cards reduces the amount of cash needed to make transactions. In this instance, the increased use of credit cards increases the velocity of money. If less money ($M1$) is in circulation, and output remains the same, then velocity has to increase.

When both sides of equation (8) are multiplied by the money supply ($M1$), the equation of exchange, which relates total output (PY) to the quantity of the money supply ($M1$) and velocity (V), is obtained.

(9) $M1V = PY$

Thus, the quantity of money ($M1$) multiplied by the number of times the money is spent in a given year (V) must equal output (PY).

A restatement of equation (9) into a percentage-change format (where ^ indicates percentage change) will show the relationship between the percentage change in money ($\hat{M}1$), the percentage change in price ($\hat{P}$), and the percentage change in output ($\hat{Y}$).

(10) $\hat{M}1 + \hat{V} = \hat{P} + \hat{Y}$

The equation of exchange can be solved for $\hat{P}$ to identify how inflation relates to money supply ($M1$) changes in the long-run.

(11) $\hat{P} = \hat{M} + \hat{V} - \hat{Y}$

This equation is used in the model to generate inflation expectations.

(12) $\hat{P}_{exp} = \hat{M} + \hat{V} - \hat{Y}$

For example, if velocity is expected to rise by one percent, real income by two percent, and money supply by five percent, then one would expect inflation of three percent.

2.2.4. Interest Rate Changes

For the sake of simplicity, the model assumes a *two-asset world*, with bonds (B) and money ($M1$) comprising total wealth (W). Intervention in the bond market by the Fed changes the supply of bonds. At the same time, the change in money ($M1$) impacts the money market. Wealth can be defined as

(13) $W = B + M1$

Figure 2 – Two-Asset World
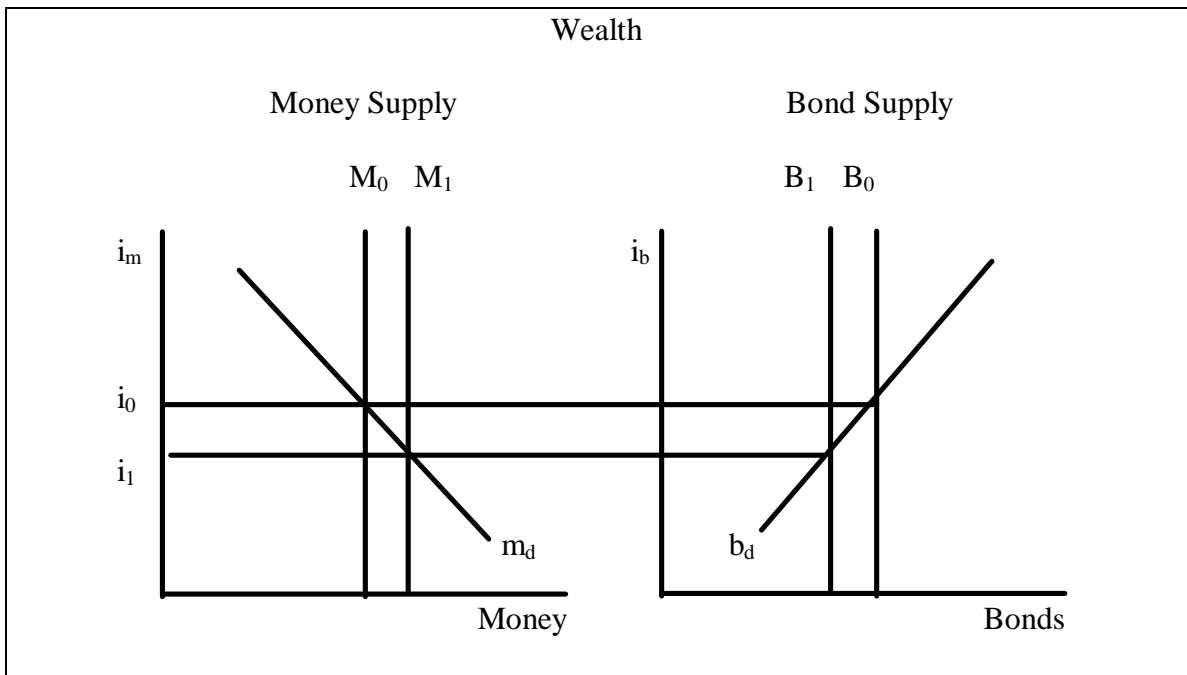
Figure 2 shows the relationship of money to bonds in the *two-asset* world. The model assumes that bond and money supplies are interest inelastic. Money demand (m_d) is negatively related to the interest rate, while bond demand (b_d) is positively related to the interest rate. In this *two-asset* world, the interest rate that clears the money market has to equal the interest rate that clears the bond market. Graphically, this implies that the slope of the money-demand curve (m_d), are of the same magnitude but of opposite signs.

As an example, consider the case of an expansionary open market operation by the Fed. Bonds are taken out the market by the Fed, through an open market transaction, in return for money. Let i_0 be the equilibrium interest rate prior to any action by the Fed.

An expansionary open market operation by the Fed will shift the money supply (M_0) curve to the right (M_1) as the bond-supply curve (B_0) moves to the left (B_1). The interest rate declines to i_1.

In equation form, the model can be written as follows. For the bond market, bond supply (B) has to equal bond demand $b(i)$ W,

(14) $B = b(i) W$

Dividing both sides of the equation by W results in

(15) $(B/W) = b(i)$

For simplicity, the share demand for bonds (b) is assumed linear and is defined as

(16) $(B/W) = a_0 + a_1 i$

where, a_0 and a_1 are values designed to provide reasonable interest rate responses to changes in the bond holdings of the Fed.

Money's ($M1$) share of wealth is calculated as

(17) $(M1/W) = (1 - a_0) - a_1 i$

The values $(1 - a_0)$ and negative a_1 make money's share of wealth consistent with bond's share of wealth.

The effect of expected inflation ($\hat{p}_{exp}$) on interest rates is important. The nominal interest rate (i) is the return to saving and the cost of borrowing without adjustment for inflation. The real interest rate (r) is the return to saving and the cost of borrowing after adjustments have been made for inflation. The real interest rate (r) is the nominal interest rate (i) less the expected inflation rate ($\hat{p}_{exp}$),

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(18) $r = i - \hat{p}_{\exp}$

An example of this calculation could be given as an agent taking a loan for one year at 10 percent (i) interest. If inflation is expected to be three percent ($\hat{p}_{\exp}$) per annum, the real interest rate can be calculated as seven percent (r).

The calculation of the expected short-term interest rate ($i_{\exp}$) in the model uses a variation of equation (18). The expected interest rate ($i_{\exp}$) is set equal to the actual interest rate (i) if expected inflation ($\hat{p}_{\exp}$) equals current inflation ($\hat{p}$). To the extent that the expected inflation rate ($\hat{p}_{\exp}$) exceeds (is below) the actual inflation rate ($\hat{p}$), the expected interest rate exceeds ($\hat{p}_{\exp}$) (is below) the current nominal interest rate (i).

(19) $i_{\exp} = i + (\hat{p}_{\exp} - \hat{p})$

This equation states that the expected short-run interest rate ($i_{\exp}$) is driven by the actual rate (i) plus the difference between expected inflation ($\hat{p}_{\exp}$) and actual inflation ($\hat{p}$).

The connection to the long-run interest rate (i_l) is provided by the yield curve. The yield curve is a representation of the term structure of interest rates. The term structure of interest rates is discussed in just about every textbook on money, banking and monetary economics.[5] The long-run interest rate calculation uses the following equation.

(20) $(1 + i_l)^n = (1 + i) \ (1 + i_{\exp})^{n-1}$

If equation (20) is restated, the long-run interest rate can be determined to be

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[5] It is suggested that the reader refer to Russell and his discussion of the term structure of interest rates (Russell, 1992).

(21) $i_l = ((1+i) \ (1+i_{\exp})^{n-1})^{1/n} - 1$

For small-expected inflation rates, the real long run interest rate can be approximated by

(22) $r_l = i_l - \hat{p}_{\exp}$

This is the well-known Fisher effect (Fisher, 1911).

Interest rate changes affect aggregate demand through variations in investment and consumption and indirectly, via exchange rate changes, exports, and imports.

2.2.5. Exchange Rates

The nominal exchange rate (e) is the rate at which one country's currency converts to another country's currency. More specifically, e is defined as the foreign currency price of one home currency unit. The real exchange rate (e_r) is equal to the nominal exchange rate (e), deflated by domestic and foreign price indices. More specifically, e_r is given as

(23) $e_r = e \ (p / p_f)$

where p is the domestic price index and p_f the foreign price index.

To determine the nominal exchange rate, the model uses uncovered interest rate parity (UIP). The UIP implies that the domestic interest rate (i) is linked to the foreign interest rate (i_f) by the following relationship

(24) $i = i_f + \hat{e}$

where $\hat{e}$ is the expected rate of depreciation of the home currency. UIP introduces exchange-rate expectations. Since the domestic interest rate (i) and the foreign interest rate (i_f) are calculated by the model, or given, the UIP relationship can be solved for the expected depreciation of domestic currency.

(25) $\hat{e} = i - i_f$

At this point the model assumes that changes in the actual exchange rate equal changes in the expected exchange rate (actual $\hat{e}$ = expected $\hat{e}$).

To calculate the real exchange rate, domestic inflation ($\hat{p}$) and foreign inflation ($\hat{p}_f$) must be compared to the negative of the exchange rate change ($\hat{e}$) because the change in the exchange rate is actually a depreciation rate. Hence, the real exchange rate ($\hat{e}_r$) is calculated as

(26) $\hat{e}_r = -\hat{e} + \hat{p} - \hat{p}_f$

In equation (26), only the real exchange rate ($\hat{e}$) is calculated. Both the change in domestic price index ($\hat{p}$) and the change in the foreign price index ($\hat{p}_f$) are entered by the user.

2.2.6. Aggregate Demand Effects

The model examines the effect of interest rate and exchange rate changes on aggregate demand by examining rates of change in each of the components of aggregate demand, $Y_d = C + I + G + X - M$. To calculate the percentage change in Y_d ($\hat{Y}_d$), one needs to (a) weight each component and (b) find the percentage change in each component. The percentage change in each demand component relies on a set of elasticity assumptions and some simple behavioral assumptions. Consumption is assumed to be a function of real income (Y) and the nominal interest rate (i), $C = C(Y,i)$. Hence, the percentage change in consumption ($\hat{C}$) is calculated as

(27) $\hat{C} = e_{CY} \ \hat{Y} + e_{Ci} \ (i - a)$

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In this equation, e_{CY} is the elasticity of consumption (C) with respect to output (Y), multiplied by the percentage change in output ($\hat{Y}$). e_{Ci} is the semi-elasticity of consumption (C) with respect to the nominal-interest rate (i). The term a is assumed to be a long-run (natural) rate of interest. If the actual interest rate climbs beyond this level, consumption growth is assumed to decline. If the actual interest rate falls below this level, consumption growth is assumed to increase. The responsiveness of the growth rate of consumption ($\hat{C}$) with respect to these changes is given by the elasticity e_{Ci}.

Investment is assumed a function of real income and the real long run interest rate, $I = I(Y, r_l)$. The percentage change in investment ($\hat{I}$) is calculated as

(28) $\hat{I} = e_{IY} \ \hat{Y} + e_{Ir} \ (r_l - b)$

In this equation, e_{IY} is the elasticity of investment (I) with respect to output (Y). The semi-elasticity of investment (I) with respect to the interest rate (r_l) is multiplied by the real long-run interest rate (r_e) less a given long-run natural rate (b). The term b is assumed a long-run (natural) rate of interest. If the actual interest rate climbs beyond this level, investment growth is assumed to decline. If the actual interest rate falls below this level, investment growth is assumed to increase. The responsiveness of the growth rate of investment ($\hat{I}$) with respect to these changes is given by the semi-elasticity e_{Ir}.

Exports are assumed to be a function of foreign income (Y_f) and the real exchange rate (e_r), $X = X(Y_f, e_r)$. Hence the percentage change in exports ($\hat{X}$) is calculated as

(29) $\hat{X} = e_{XY_f} \ \hat{Y}_f + e_{Xe_r} \ \hat{e}_r$

In this equation, e_{XY_f} is the elasticity of exports (X) with respect to foreign output (Y_f). The elasticity of exports (X) with respect to the real exchange rate (e_r) is multiplied by the percentage change in the real exchange rate ($\hat{e}_r$).

Imports are assumed a function of domestic real income and the real exchange rate, $M = M$ (Y, e_r). Hence, the percentage change in imports (M) is calculated as

(30) $\hat{M} = e_{MY} \ \hat{Y} + e_{Me_r} \ \hat{e}_r$

In this equation, e_{MY} is the elasticity of imports (M) with respect to output (Y). The elasticity of imports (M) with respect to the real exchange rate (e_r) is multiplied by the percentage change in the real exchange rate ($\hat{e}_r$).

The percentage change in output ($\hat{Y}_d$) is calculated as a weighted average of the percentage change of the aggregate demand components.

(31) $\hat{Y}_d = c \ \hat{C} + d \ \hat{I} + e \ \hat{G} + f \ \hat{X} - g \ \hat{M}$

In this equation, the multipliers (c), (d), (e), (f), and (g) are the weights of the aggregate demand components, and g is the percentage change in government expenditures on goods and services, which is assumed to be exogenously given.

2.2.7. Phillips Curve

For modeling a "normal" low inflation economy, the Phillips curve is used. The Phillips curve can connect - for a short to medium time horizon - changes in output that move the economy away from its natural rate and inflation expectations to the actual inflation rate.

The normal expectations-augmented Phillips curve (not expressed as a rate of change) appears as follows

(32) $\hat{P}_{new} = \hat{p}_{exp} - \boldsymbol{b}\,(\boldsymbol{m} - \boldsymbol{m}^n) + \boldsymbol{p}$

In this equation the new inflation rate ($\hat{P}_{new}$) is calculated as the expected inflation rate ($\hat{p}_{exp}$) less the difference between the actual and the natural rate of unemployment $\boldsymbol{b}(\boldsymbol{m} - \boldsymbol{m}^n)$, plus a random shock variable ($\boldsymbol{p}$).

The model incorporates a "rate of change form" to model the Phillip's curve. We assume that expected inflation ($\hat{p}_{exp}$) does not directly enter the calculation of $\hat{P}_{new}$. Rather, inflation expectations for the purpose of the Phillips curve calculations are a weighted average of actual and expected inflation, where expected inflation ($\hat{p}_{exp}$) receives a weight of k and actual inflation ($\hat{p}$) a weight of 1-k. This assumption is based on the idea of adaptive rather than rational expectations. The model does not use unemployment rates as an excess demand indicator, but the difference of the growth rate of aggregate demand and the growth rate of aggregate supply. Hence, the model calculates the new inflation rate ($\hat{P}_{new}$) as

(33) $\hat{P}_{new} = h\,(\hat{Y}_d - \hat{Y}) + (k\ \hat{p}_{exp} + (1-k)\,\hat{p}) + \boldsymbol{p}$

Expected and actual inflation receive a weight of k and 1-k, respectively. Random shocks ($\boldsymbol{p}$) can be introduced to allow for unexpected changes in the economy.

2.3. The Electronic Model

2.3.1. Why a Spreadsheet Model

A spreadsheet format is chosen for this model because of the general availability of the software to both teachers and students. Other models written in proprietary formats often limit the teacher and student to fixed lines of instruction. The use of spreadsheets is beneficial in that it not only teaches the process, but also allows the student to view the actual cell calculations that generate the results.

The use of widely accepted spreadsheet software, such as Excel, avoids the problem of system incompatibilities. Proprietary programs often require certain memory and disk space requirements to run. Excel, as part of Microsoft's Office package, is pre-configured to run on the user's PC, thus avoiding any potential system conflicts.

The overall acceptance of Excel as a mainstream spreadsheet package ensures users that skills developed through use of the model will not be wasted. This acceptability places the user at ease with the functionality of the spreadsheet.

2.3.2. Data Sources

All models are deficient in some way when outcomes are compared to the actual economy. This model cannot be presumed to be any more or less accurate in portraying outcomes than other models. For the model to obtain outcomes that reflect those seen in the economy, certain assumptions are made. These include, foreign interest rates and inflation rates, starting domestic inflation, and numerous elasticities and weighting factors. Where possible, actual data are included to represent the state of the U.S. economy at the time of publishing.

2.3.3. Spreadsheet Cell Reference Description Methodology

Discussion of the model's development requires an understanding of the cell reference and naming conventions used in the model. The filename of the model is FRACBANK.XLS. The model is divided by topics onto different sheets within the file. Sheet reference names appear on tabs at the bottom of the screen. Movement between sheets can be accomplished by clicking on the sheet tab with the mouse pointer. Within each sheet, the model uses common cell-referencing techniques. Cell references relate to columns (referenced by alpha sequence) and rows (referenced by numerical sequence). Discussions of calculations will reference sheets and cells as follows:

- 'Fractional Reserve Example' – refers to the sheet within the file
- Cell A1 – refers to the cell location within the above sheet
- 'Description' – will detail the descriptive contents of the cell

As an example, the reference to the counter used to cycle through the money creation steps appears as follows: *'Fractional Reserve Example' – cell C15 – Step.*

Throughout this document, hyperlinks are used to allow the reader to jump from documentation to the actual spreadsheet application. A hyperlink reference will appear as follows: *To access this section of the spreadsheet, the user clicks on the following link: FRACBANK.XLS - 'Fractional Reserve Example'!a1.* By clicking the mouse pointer on the underlined portion of the statement above, the user moves to the cell referenced in the spreadsheet.

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2.3.4. Base scenario - Fractional Reserve Example

The balance sheet of the Fed is divided into Assets and Liabilities. Government Bonds, Foreign Currency, and Gold are on the asset side (other items will appear on the model spreadsheet but will be addressed later). On the liability side of the balance sheet, are currency and bank reserves.

The asset side of the balance sheet is key to the money creation and transmission process. Transactions can be made in the bond market, gold market, or foreign currency market. Activity on the central bank reserve side is matched by activity in individual-bank balance sheets. All movements are seen as activities on each of the bank's balance sheets. The Fed balance sheet and the affected individual banking sheets appear on one sheet (*Fractional Reserve Example*). This displays the core of the banking system (whether the basis of that central bank system operates through open-market operations, currency board, or the gold standard). The fractional reserve bank example allows an option for cash withdrawals by the public and excess reserves held by banks. Reserves held at the Fed show up in the Fed balance sheet.

At the bottom of the individual bank's balance sheet is a *Summary of the Money Creation Process*. Aside from regular banking transactions, the model tracks the progress of how much inside and outside money is created. The model tracks *M1* and the monetary base (*MB*) as the money creation process is modeled. This section also allows the student to see how the money multiplier changes as transactions occur. Changes in the money multiplier are important to understand, because the Fed tries to influence inflation via changes in the monetary base. This monetary base, however, is connected to

the money supply via the money multiplier, which is only partly under the control of the Fed.

Entries driving the model are made on the *Fractional Reserve Example* sheet. This sheet allows the entry of basic assumptions. This assumption sheet is set out in Figure 3.

Data for this basic assumption sheet come from *The Federal Reserve Bulletin* July 1998; *Combined Statements of Condition* for December 31, 1997, and 1996, page 576. These data can be updated as new bulletins are issued. The mapping of the bulletin data to the input screens above can be found in Appendix C. For detailed descriptions of individual items mentioned on the Federal Reserve Balance Sheet the user can go to the Federal Reserve web site.[6]

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[6] Federal Reserve web site - http://www.federalreserve.gov/pf/pdf/frspfap.pdf. This document details each balance sheet, line-item description.

Figure 3 - Assumptions – Base scenario

Fractional Reserve Banking					
Basic Assumptions					
Central Bank Assets	$ bill.	Transaction	Central Bank Liabilities	$ bill.	
Discount Loans	$ 2		Currency	$ 457	
Bond Holdings	$ 459	$ 12.0	Bank Reserves	$ 37	
FC Holdings	$ 17	$ -	Liability Other	$ 9	
Gold Holdings	$ 11	$ -	Total Liabilities	$ 503	
Assets Other	$ 25		Central Bank Capital	$ bill.	
Total Assets	$ 514		Total Capital	$ 11	
Banking Variables	%		Total Liabilities and Capital	$ 514	
Res Dep Ratio	10.00		Economy	$ bill.	
Excess Res.	7.50		Market Bond Supply	$ 5,745	
Public Preferences	%		Initial M1	$ 1,081	
Cash Holdings	14.19		Initial Financial Wealth	$ 6,826	
Step	17	(1 to 17)			
When the process runs to completion, we have a new M1 and Money Multiplier that is based on the parameters that are in effect for the assumed changes.					

To access this section of the spreadsheet, the user clicks on the following link:

FRACBANK.XLS - 'Fractional Reserve Example'!a1

A comparison between the model *Basic Assumptions* sheet (Figure 3) and the Fed balance sheet as shown in the bulletin will reveal that the electronic model condenses Fed balance sheet items into fewer totals. The spreadsheet model also has added an *Economy* section and a *Banking Variables* section. These do not appear in the Fed balance-sheet items. The *Economy* section of the screen is derived from the June 1998 *Economic Indicators* as prepared for the *Joint Economic Committee by the Council of Economic Advisors*. This report includes all data available as of July 7, 1998. The mapping of these indicators to the spreadsheet can be found in Appendix D. Under the *Banking*

variable section of the spreadsheet are the *Reserve Deposit Ratio*, and *Excess Reserves* cells that allow the user to change these variables. The July 1998 *Federal Reserve Bulletin* set deposit requirements at 10 percent for net transaction accounts of more than $47.8 million.[7] This percentage is used as the basis for the *Reserve Deposit Ratio* set out in the model. *Excess Reserves* are at the discretion of the user to show the effect of the system voluntarily holding additional reserves. *Excess Reserves* are initially set to 7.5 percent, an estimate of excess reserves in the banking sector. Under the *Public Preferences* variable section, *Cash Holdings* reflect the amount of cash that the public wishes to hold. *Cash Holdings* are initially set to 14.19 percent of demand deposits. This number is the result of calibrating the model to generate an equilibrium outcome for the default-input numbers.

The *Central Bank Assets* section allows the user to enter and/or vary quantities as set out in Table 1. Entries in the following tables are comprised of three types of data.

- User input (User) – used throughout the model to allow the user to estimate monetary policy.

- Calculated data (Calc) – calculated from other portions of the model.

- Economic data (Data) – these are either data based on economic sources, such as data representative of the U.S., or data assumptions used in the model.

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[7] Federal Reserve Bulletin, Board of Governors of the Federal Reserve System, Washington D.C., Vol. 84, No. 7 (July 1998): A8.

Table 1 - Central Bank Assets

CELL DESCRIPTION	DATA SOURCE
Discount Loans	Initial entry only (Data)
Bond holdings	Initial entry (Data)
Bond Transaction	Initial entry (Data) and user modification (User)
Foreign Currency Holdings	Initial entry (Data)
Foreign Currency Transaction	User modification (User)
Gold Holdings	Initial entry (Data)
Gold Transaction	User modification (User)
Assets Other	Calculated as total assets less the sum of discount loans, bond holdings, foreign currency holdings, and gold holdings. (Calc)
Total Assets	Initial entry only (Data)

All balances are recorded in billions of dollars. The display of market transactions in the *Transactions* column next to the *$ bill.* column in Figure 3 allows the user to enter a positive or a negative transaction to drive changes throughout the example.

The *Central Bank Liabilities* section allows the user to enter quantities as set out in Table 2.

Table 2 - Central Bank Liabilities

CELL DESCRIPTION	DATA SOURCE
Currency	Initial entry only (Data)
Bank Reserves	Initial entry only (Data)
Liability Other	Initial entry only (Data)

These balances are pre-set to levels representative of the U.S. economy. The asset and liability side of the *Fractional Reserve Banking* sheet must balance - i.e. *Assets* $514 bill. = *Liabilities* $514 bill.

The *Banking Variables* and *Public Preferences* section is used to allow the user to enter changes as set out in Table 3.

Table 3 - Banking Variables and Public Preferences

CELL DESCRIPTION	DATA SOURCE
Reserve Deposit Ratio	Both initial entry (Data) and transaction quantities (User). Represents required reserves percentage (*rr*).
Excess Reserves held by banks	Both initial entry (Data) and transaction quantities (User). Represents reserves in excess of those required by the Fed as a percentage (*er*).
Cash Holdings	Both initial entry (Data) and transaction quantities (User). Cash held by the public as a percentage (*cr*).

These transactions are made in percentage form. Changes to these cells should be made in whole numbers - i.e. to enter 10 percent, enter 10.

The *Economy* section allows the user to enter base scenario variables as set out in Table 4.

Table 4 - Economy

CELL DESCRIPTION	DATA SOURCE
Market Bond Supply	Initial entry only (Data)
Initial M1	Initial entry only (Data)
Initial Financial Wealth	Calculated as the sum of market bond supply and initial M1 (Calc)

2.3.5. Base scenario - Stepping through the Model

Leaving the starting variables unchanged for this first scenario, the student is ready to begin stepping through the money creation process. Just below the *Banking Variables* section of the spreadsheet is a counter that allows the user to specify which

step in the process of money creation is to be shown *('Fractional Reserve Example' – cell C15 - Step)*. This counter either can be manually entered to a number between 0 and 17 or can be changed via the spinner arrows. The up arrow, when pressed, will count-up the number line. The down arrow will count-down the number line.

At the bottom of the *Basic Assumptions* section there is a text description of the step that has just taken place. This description can be up to six lines long. As the *Step* counter is moved, data within the balance sheets update along with the text description of the actions taking place. Figure 4 summarizes transactions from the central bank's viewpoint. Individual member bank transactions are processed through the central bank, showing deposit creation. On the left side of the *Central Bank Balance Sheet*, *Changes ($ bill)* shows changes in bond holdings (*Bonds*), foreign currency unit (*FCU*), or gold (*Gold*) holdings. On the right side of the balance sheet, *Changes ($ bill)* shows changes in *Currency* and *Bank Reserves*. Change activity on the bank reserve side of the central bank is matched by activity in bank balance sheets (Figure 5), displaying the methodology of fractional reserve banking.

Figure 4 - Central Bank Balance Sheet – Base scenario

Central Bank Balance Sheet											
Changes ($ bill.)						**Levels ($ bill.)**					
Assets			*Liabilities*			*Assets*			*Liabilities*		
DL	$	-	Currency	$	-	DL	$	2.04	Currency	$	457.47
Bonds	$	12.00	Bank Res.			Bonds			Bank Res.		
			Bank A	$	12.00		initial $	458.56		initial $	36.96
				$	(8.49)		final $	470.56		final $	48.96
			Bank B	$	8.49						
FC	$	-		$	(6.01)	FC					
			Bank C	$	6.01		initial $	17.05			
				$	(4.26)		final $	17.05			
Gold	$	-	Bank D	$	4.26	Gold			Capital	$	10.65
							initial $	11.05			
							final $	11.05			
						Other	$	25.24	Other	$	8.84
Sum	$	12.00	Sum	$	12.00	Sum Initial	$	513.92	Sum Initial	$	513.92
Step				17	(1 to 17)	Sum Final	$	525.92	Sum Final	$	525.92

To access this section of the spreadsheet, the user clicks on the following link:

FRACBANK.XLS - 'Fractional Reserve Example'!a22

The model deals with both changes and levels in the economy. The right hand side of the *Central Bank Balance Sheet* sets out both the *initial* and *final* levels attained through the transactions that are made in the assumptions and money creation process. This section of the model is driven by the assumptions entered in the *Basic Assumptions* section and the position of the *step* counter throughout the process. *Final* settings appear in this section when the counter reaches 17.

The *Basic Assumptions*, *Central Bank Balance Sheet*, and the *T Accounts of Individual Banks* appear on the same sheet, *Fractional Reserve Example*. The interaction

between these sections models the core of the fractional banking system. Figure 5 sets out the T accounts for each of the individual banks in the fractional banking process.

Below the *Central Bank* section of the spreadsheet, the T accounts for four individual banks appear (A through D). These fictitious banks loan all funds in excess of their required reserves and excess reserves. As the step counter moves from 0 to 17, each balance-sheet entry appears in the relevant bank section and is described in the description box below the counter (*'Fractional Reserve Example' – cell A16 Description*). Once the transaction process gets to bank D, the model jumps through a number of transactions to the point that it can display the end of the money-creation process.

Figure 5 - Individual Bank T Accounts – Base scenario

T Accounts of Individual Banks (Changes in $ bill.)							
Bank A Balance Sheet				**Bank B Balance Sheet**			
Assets		*Liabilities*		*Assets*		*Liabilities*	
Cash	$ (1.70)	DD	$ 12.00	Cash	$ (1.21)	DD	$ 8.50
Res.	$ 12.00		$ (1.70)	Res.	$ 8.50		$ (1.21)
of which VExRs	$ 0.77			of which VExRs	$ 0.55		
	$ (8.50)	DD-Loan	$ 8.50		$ (6.01)	DD-Loan	$ 6.01
Loans	$ 8.50		$ (8.50)	Loans	$ 6.01		$ (6.01)
Sum	$ 10.30		$ 10.30		$ 7.29		$ 7.29
Step		17	(1 to 17)	**Note: VExRs = Voluntary Excess Reserves**			
Bank C Balance Sheet				**Bank D Balance Sheet**			
Assets		*Liabilities*		*Assets*		*Liabilities*	
Cash	$ (0.85)	DD	$ 6.01	Res.	$ 4.26	DD	$ 4.26
Res.	$ 6.01		$ (0.85)				
of which VExRs	$ 0.39						
	$ (4.26)	DD-Loan	$ 4.26				
Loans	$ 4.26		$ (4.26)				
Sum	$ 5.16		$ 5.16		$ 4.26		$ 4.26

To access this section of the spreadsheet, the user clicks on the following link:

FRACBANK.XLS - 'Fractional Reserve Example'!a41

The *Summary of the Money Creation Process* is shown in Figure 6. This figure displays *MB, M1, Total Reserves,* and the new *Implied Money Multiplier*.

Figure 6 - M1 Summary – Base scenario

Summary of Money Creation Process							
Action	**Changes in $ bill.**			**Levels in $ bill.**		**Implied Money**	
	MB	**M1**	**Total Res.**	**MB**	**M1**	**Multiplier**	
In old equil.				$ 494.43	$ 1,080.90	
After 1 round	$ 12.00	$ 12.00	$ 12.00	$ 506.43	$ 1,092.90	
After 2 rounds	$ 12.00	$ 20.49	$ 10.30	$ 506.43	$ 1,101.39	
After 3 rounds	$ 12.00	$ 26.51	$ 9.09	$ 506.43	$ 1,107.41	
After 4 rounds	$ 12.00	$ 30.76	$ 8.24	$ 506.43	$ 1,111.66	
In new equil.	$ 12.00	$ 43.24		$ 506.43	$ 1,124.14	3.60
Step		17	(1 to 17)			

To access this section of the spreadsheet, the user clicks on the following link:

FRACBANK.XLS - 'Fractional Reserve Example'!a62

Table 5 sets out the sources and calculations required for the *Money Creation Process* portion of the model.

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Table 5 - Summary of Money Creation Process

CELL DESCRIPTION	DATA SOURCE
Changes - MB	Referenced from the bond holdings transactions entered by the user to change the model. (Calc)
Changes - M1	Calculate as the sum of demand deposits in each of bank A, bank B, bank C, and bank D's individual balance sheets. (Calc)
Changes – Total Reserves	Calculated as the sum of bank A, bank B, bank C, and bank D reserves held at the central bank. (Calc)
Levels – MB	Calculated as the sum of the original equilibrium MB and the bond holding transaction amount that raises MB in the first round of money creation. (Calc)
Levels – M1	Calculated as the sum of the original M1 plus the M1 created in each new round of money creation. (Calc)
Money Multiplier	Refer to equation (6) for the money multiplier calculation. This equation is driven off step 17 and the completion of the money creation process. (Calc)

Aside from regular banking transactions, this section tracks the progress of how much money has been created. The model tracks *M1* and the money base (*MB*), as the money creation process evolves from step 1 through step 17. New *M1* totals appear on this section of the model after steps 4, 8, 12, 16, and 17, as each round of money making is complete. Step 17 takes the model through to the end of the deposit creation process and shows the new equilibrium balances. In step 17, the new money multiplier appears allowing comparison to the base-run initial money multiplier.

2.3.5.1. Base scenario - The Equation of Exchange and the Impact of Money on the Economy

The equation of exchange links the change in the money supply to changes in inflation. It is used in the model to generate inflationary expectations.

Figure 7 - Equation of Exchange – Base scenario

M1, the Equation of Exchange and Inflation Expectations		
Variables		$ bill.
Percentage Change in Monetary Base		12 %
New M1 money supply level		$ 1,124
New Bond supply level		$ 5,733
Percentage Change in M1		4.00 %
Assumed Percentage Change in Y		2.50 %
Assumed Percentage Change in Velocity		1.00 %
Expected Percentage Change in Price (Expected inflation)		2.50 %
Step	17 (1 to 17)	

To access this section of the spreadsheet, the user clicks on the following link:

FRACBANK.XLS - 'Equation of Exchange'!a1

Figure 7 sets out variables that are used elsewhere in the model. Variables that are highlighted in gray may be changed by the user, while non-highlighted variables are driven by the *Fractional Reserve Example* sheet (changes made on that sheet will be reflected here).

In this sheet, several calculations and a few basic assumptions provide a starting point. Table 6 sets out the source and calculation of each of the entries above.

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Table 6 - M1, the Equation of Exchange and Inflation Expectations

CELL DESCRIPTION	DATA SOURCE
Change in Monetary Base	Direct reference to changes as user enters bond transaction quantities. (Calc)
New M1 Money Supply Level	Total of initial *M1* + additional *M1*. (Calc)
New Bond Supply Level	Original bond supply – bond transaction qty. (Calc)
Percentage Change in M1	Change in *M1* / *M1*. (Calc)
Assumed Percentage Change in Y	Initial entry 2.5 percent (Data). This entry is estimated based on actual GDP results over the last few decades. The average for the last 38 years has been 3.22 percent, however, the model uses a more conservative estimate of 2.5 percent. A GDP table is attached in Appendix E or available at (http://www.whitehouse.gov/fsbr/output.html) This entry may also be changed by the user. (User)
Assume Percentage Change in Velocity	Initially set to 1 (Data). This entry is chosen to reflect the fact that velocity does change. Until the early 80's, velocity had remained constant. During that decade, the relationship between velocity and GDP broke down. This entry reflects the possibility of change. It is entered as a "comparison level," rather than as a representation of actual occurrences in the economy. This entry may also be changed by the user. (User)
Expected Percentage Change in Price (Expected Inflation)	Percentage change in *M1* – assumed percentage change in Y + assumed percentage change in velocity. (Calc)

2.3.5.2. Base scenario - The Impact of Money on Interest Rates

Figure 8 shows the derivation of the nominal short-run interest rate for both the bond and money market. This figure depicts the numerical equivalent of Figure 2 and equations (18) and (19).

Figure 8 - Interest Rates – Base scenario

<table>
<tr><td colspan="7">The Impact of Money on Interest Rates</td></tr>
<tr><td colspan="7">(short and long run)</td></tr>
<tr><td colspan="3">Share of bonds in fin. Wealth</td><td colspan="4">Bond demand as a function of the interest rate</td></tr>
<tr><td>Equation 1</td><td>0.84</td><td>=</td><td>0.828556205</td><td>+</td><td>0.0015</td><td>i</td></tr>
<tr><td colspan="3">Share of money in fin. Wealth</td><td colspan="4">Money demand as a function of the interest rate</td></tr>
<tr><td>Equation 2</td><td>0.16</td><td>=</td><td>0.171444</td><td>-</td><td>0.0015</td><td>i</td></tr>
<tr><td>Adding up Constraint</td><td>1.00</td><td>=</td><td>1.000000</td><td>+</td><td>0.0000</td><td></td></tr>
<tr><td colspan="5">Equation 1 equilibrium interest rate</td><td>5.00</td><td>%</td></tr>
<tr><td colspan="5">Equation 2 equilibrium interest rate</td><td>5.00</td><td>%</td></tr>
<tr><td colspan="7">Term Structure</td></tr>
<tr><td colspan="3">Implied Long Run i</td><td colspan="2">Current Short Run i</td><td colspan="2">Expected Short Run i</td></tr>
<tr><td colspan="3">5.00 %</td><td colspan="2">5.00 %</td><td colspan="2">5.00 %</td></tr>
<tr><td colspan="7">Note: the expected short-run rate is calculated as the actual nominal rate,
plus the difference between expected inflation rate, and actual inflation rate.</td></tr>
<tr><td>Step</td><td>17</td><td colspan="5">(1 to 17)</td></tr>
</table>

To access this section of the spreadsheet, the user clicks on the following link:

[FRACBANK.XLS - 'Impact of Money on Interest'!a1](FRACBANK.XLS)

Table 7 sets out the data sources and calculations used to drive this portion of the model.

Table 7 - The Impact of Money on Interest Rates

CELL DESCRIPTION	DATA SOURCE
Bond Demand as a Function of the Interest Rate	The coefficients for bond demand on the right side of the equal sign are fixed. These entries are calculated and inserted into the model to generate a realistic response of the interest rate to bond supply changes. These coefficients should not be modified by the user. (Calc)
Money Demand as a Function of the Interest Rate	The coefficients for money demand on the right side of the equal signs are fixed. These entries are tied to the coefficients of the bond demand equation, through the adding up constraint. (Calc)
Share of Bonds in Financial Wealth	Bonds / (bonds + $M1$). (Calc)
Share of Money in Financial Wealth	M1 / (bonds + $M1$). (Calc)
Adding Up Constraint	Sum of share of equations 1 and 2. Ensuring that both the bond market and money market clear. Refer to Figure 2. (Calc)
Equation 1 equilibrium interest rate	This solves equation 1 for the interest rate (i). (Calc)
Equation 2 equilibrium interest rate	This solves equation 2 for the interest rate (i). (Calc)
Current Short-run interest rate	The Equation 1 equilibrium interest rate. (Calc)
Expected Short-run interest rate	Derived from equation (19). (Calc)
Implied Long-run interest rate	Calculated via the yield curve as set out in equation (21). A ten year time horizon is chosen for the calculation of equation (21). (Calc)

2.3.5.3. Base scenario - The Impact of Money on Exchange Rates

Having finalized calculations on the interest rates, the model now examines the impact of interest rate changes on nominal and real exchange rates in Figure 9.

Figure 9 - Exchange Rates – Base scenario

The Impact of Money on Nominal and Real Exchange Rates	
Definitions	*Values*
i – Domestic Short-run Nominal Interest Rate, percent	5.00
Assumed Foreign Real Interest Rate, percent	2.50
if – Foreign Short Run Nominal Interest Rate, percent	3.50
(i - if) – Expected Rate of Depreciation of Domestic Currency, percent	1.50
Assumed Foreign Inflation Rate, percent	1.00
Assumed Domestic Inflation Rate, percent	2.50
Calculation of Real Exchange Rate	
Implied percentage change of real exchange rate = (% chng in e + % chng in p - % chng in pf)	0.00
Note: assuming that expected rates equal actual rates on average (rational Expectations are assumed here).	
Step	17 (1 to 17)

To access this section of the spreadsheet, the user clicks on the following link:

FRACBANK.XLS - 'Impact of Money on Nominal Exch'!a1

Table 8 sets out the data sources and calculations used to drive this portion of the model.

Table 8 - Calculation of Real Exchange Rate

CELL DESCRIPTION	DATA SOURCE
Domestic Short-run Nominal Interest Rate (percent)	Calculated in Figure 9 from bond and money market equilibrium conditions. This formula is discussed in the model theory section as equation (18.) (Calc)
Assumed Foreign Real Interest Rate (percent)	Assumed to be 2.5 percent (Data and User)
Foreign Short-run Nominal Interest Rate (percent)	Calculated as the sum of the assumed foreign interest rate and the Assumed Foreign Inflation Rate. (Calc)
Expected Rate of Depreciation of Domestic Currency (percent)	Calculated as short-run interest rate minus foreign short-run interest rate. (Calc)
Assumed Foreign Inflation Rate (percent)	Entered by the user. Assumed to 1 percent for the base scenario. (Data and User)
Assumed Domestic Inflation Rate (percent)	Assumed to be 2.5 percent. Appendix F gives the actual CPI data for the last 50 years. (Data and User)
Implied Percentage Change in Real Exchange Rate	Calculated as (minus expected rate of depreciation of domestic currency + assumed domestic inflation rate – foreign inflation rate). Refer to equation (26) in the model theory section. (Calc)

2.3.5.4. Base scenario - Consumption

This section is based on the simple assumption that consumption growth equals the income elasticity of consumption times income growth plus a particular fraction that is determined by the interest rate being above or below five percent. Equation (27) provides the background to this section.

Figure 10 - Consumption – Base scenario

Consumption		
Income Growth	*Interest Rate Effect*	*Consumption Growth*
2.50 %	0.00 %	2.50 %
Step	17 (1 to 17)	

To access this section of the spreadsheet, the user clicks on the following link:

FRACBANK.XLS - 'Impact of Money on Real Sector'!a1

Table 9 sets out the data sources and calculations used to drive this portion of the model.

Table 9 - Consumption

CELL DESCRIPTION	DATA SOURCE
Income Growth Effect	Income Growth is assumed; the income elasticity of consumption is assumed to be unity. (Calc)
Interest Rate Effect	Calculated as -0.25 multiplied by the difference between the current short-run interest rate and 5, where 5 represents the long-run natural rate of interest (*a* in equation (27)). The entry 0.25 represents a fixed number to represent the semi-elasticity of consumption with respect to the interest rate. (Calc)
Consumption Growth	Calculated as income growth effect plus interest rate effect. (Calc)

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2.3.5.5. Base scenario - Investment

Investment is driven by both income and interest rate changes. Long-run interest rate calculations are provided in equation (21).

Figure 11 - Investment – Base scenario

Investment		
Real Long Run Rate	2.50 %	
Income Growth	**Interest Rate Effect**	**Investment Growth**
3.75 %	0.00 %	3.75 %
Step	17 (1 to 17)	

To access this section of the spreadsheet, the user clicks on the following link:

FRACBANK.XLS - 'Impact of Money on Real Sector'!a8

Table 10 sets out the data sources and calculations used to drive this portion of the model.

Table 10 - Investment

CELL DESCRIPTION	DATA SOURCE
Real Long-run Rate of Investment	Calculated as long-run interest rate minus expected percentage change in price. (Calc)
Income Growth Effect	Calculated as 1.5 multiplied by the assumed percentage change in Y. Refer to equation (28) where e_{IY} is the semi-elasticity of investment (I) with respect to output (Y). The entry 1.5 represents this elasticity.
Interest Rate Effect	Calculated as -0.5 multiplied by (real long-run rate – 2.5). Refer to equation (28) where e_{Ir} is the semi-elasticity of Investment (I) with respect to the interest rate (r). The entry 0.5 represents the chosen semi-elasticity.
Investment growth	Calculated as the sum of income growth effect and interest rate effect.

2.3.5.6. Base scenario - Net Exports

Imports and exports are dependent on domestic income growth and foreign income growth, respectively. In addition, both depend on the real exchange rate. The calculations are done in growth rate form in analogy to those for consumption and investment.

Figure 12 - Net Exports – Base scenario

Net Exports			
Assumed Foreign Output Growth		2.50	
Exports	*Foreign Inc Growth*	*Exchange Rate Effect*	*Export Growth*
	2.50 %	0.00 %	2.50 %
Imports	*Income Growth*	*Exchange Rate Effect*	*Import Growth*
	3.75 %	0.00 %	3.75 %
Step	17	(1 to 17)	

To access this section of the spreadsheet directly the user clicks on the following link: FRACBANK.XLS - 'Impact of Money on Real Sector'!a17

Table 11 sets out the data sources and calculations used to drive this portion of the model.

Table 11 - Net Exports

CELL DESCRIPTION	DATA SOURCE
Assumed Foreign Output Growth	Entered by user. 2.5 percent is selected for the base scenario. (Data and User).
Foreign Income Growth Effect for Exports	Calculated as one times foreign output growth, where one is the assumed elasticity of exports with respect to foreign income. Refer to equation (29) where $\hat{Y}_f$ is the percent change in foreign income. (Calc)
Exchange Rate Effect for Exports	Calculated as -0.1 multiplied by percentage change of real exchange rate. Refer to equation (29) where e_{Xe_r} is the elasticity of exports with respect to the exchange rate. The entry (-0.1) represents this elasticity. (Calc)
Export Growth	Calculated as the sum of foreign income growth and the exchange rate effect. (Calc)
Income Growth Effect for Imports	Calculated as 1.38 multiplied by percentage change in Y. Refer to equation (30) where e_{MY} is the elasticity of imports with respect to the output. The entry 1.38 represents this elasticity. (Calc)
Exchange Rate Effect for Imports	Calculated as 0.1 multiplied by exchange rate effect. Refer to equation **(30)** where e_{Me_r} is the elasticity of imports with respect to the exchange rate. The entry 0.1 represents this elasticity. (Calc)
Import Growth	Calculated as the sum of income growth effect and the exchange rate effect. (Calc)

2.3.5.7. Base scenario - Aggregate Demand

As mentioned in the theory discussion, the model examines the effect of interest rate and exchange rate changes on aggregate demand by examining rates of change in each of the aggregate expenditure functions. The model makes use of weights to aggregate the individual expenditure categories. These weights are set out below in Figure 13. The weight for each category is arrived at by dividing each category specific number by the total for aggregate demand. For example, the weight of consumption is calculated as the ratio between 4.5 and 7, and the weight of investment as 1 divided by 7.

Figure 13 - Aggregate Demand – Base scenario

Weighting Scheme for Aggregate Demand	
Consumption	4.5
Investment	1
Exports	1
Government	1.5
Imports	1
Total Aggregate Demand	*7*
Growth of Aggregate Demand	
Share of C x Growth of C	1.61
Share of I x Growth of I	0.54
Share of X x Growth of X	0.36
Share of G x Growth of G	0.54
Share of M x Growth of M	0.54
Growth of Aggregate Demand	*2.50*
Step	17 (1 to 17)

To access this section of the spreadsheet, the user clicks on the following link:

FRACBANK.XLS -'Impact of Money on Real Sector'!a28

Table 12 sets out the data sources and calculations used to drive this portion of the model.

Table 12 - Growth of Aggregate Demand

CELL DESCRIPTION	DATA SOURCE
Share of C x Growth of C	Calculated as (consumption / total) multiplied by consumption growth. (Calc)
Share of I x Growth of I	Calculated as (investment / total) multiplied by investment growth. (Calc)
Share of X x Growth of X	Calculated as (exports / total) multiplied by export growth. (Calc)
Share of G x Growth of G	Calculated as (government / total) multiplied by assumed percent change in *Y*. (Calc)
Share of M x Growth of M	Calculated as (imports / total) multiplied by import growth.) (Calc)
Growth of Aggregate Demand	Calculated as: the sum of each of the above components of aggregate demand growth. Refer to Equation (31). (Calc)

2.3.5.8. Base scenario - Phillips Curve

Inflation is a function of the growth rate of aggregate demand being above or below output growth, expected inflation (assuming adaptive expectations), and random supply shocks.

Figure 14 - Phillip's Curve – Base scenario

Phillips Curve		
Variable		**Result**
Aggregate Demand vs Aggregate Supply		0.00 %
Expected Inflation Effect		2.50 %
Random Supply Shock		0 %
New Inflation Rate		**2.50 %**
Step	17	(1 to 17)

To access this section of the spreadsheet, the user clicks on the following link:

FRACBANK.XLS - 'Impact of Money on Real Sector'!a44

Table 13 sets out the data sources and calculations used to drive this portion of the model.

Table 13 - Phillips Curve

CELL DESCRIPTION	DATA SOURCE
Aggregate Demand vs Aggregate Supply	Calculated as 2.5 times (growth of aggregate demand minus the assumed percentage change in *Y*.) Refer to equation (33) where *h* represents the 2.5 multiplier, and $\left(\hat{Y}_d - \hat{Y}\right)$ represents the difference between the growth of aggregate demand and the assumed percentage change in *Y*. (Calc)
Expected Inflation	Calculated as (0.20 times expected inflation) plus (0.8 times actual inflation.) Refer to equation (33) where the entries 0.20 and 0.8 are weights of the expected and actual inflation rates. (Calc)
Random Supply Shock	This entry allows one to enter a random supply shock that effects the interest rate. Refer to equation (33) where the variable *p* is introduced in the equation. (Data and User)
New inflation rate	Calculated as the sum of the three above factors. (Calc)

2.3.5.9.   Base scenario - Summary Table with Base scenario and Final Results

The sheet titled *Summary Table* displays the *Base scenario* and *Final* results of the model.   The step counter should be set to 17 (the final round) to display the full impact of the variables that have been entered.   The *Summary Table* appears as follows:

Figure 15 - Summary – Base scenario

Summary Table with Basic Assumptions and Results		
Assumed Exogenous Growth Rates		
Output		2.50 %
Foreign Output		2.50 %
Levels and Growth Rates	*Base scenario*	*Final*
M1 growth	4.00 %	4.00 %
nominal short run interest rate	5.00 %	5.00 %
nominal long run interest rate	5.00 %	5.00 %
real long run interest rate	2.50 %	2.50 %
inflation (Phillips curve)	2.50 %	2.50 %
expected depreciation	1.50 %	1.50 %
percent change in real e	0.00 %	0.00 %
Resulting percentage changes	*Base scenario*	*Final*
Consumption	2.50 %	2.50 %
Investment	3.75 %	3.75 %
Exports	2.50 %	2.50 %
Imports	3.75 %	3.75 %
Aggregate demand	2.50 %	2.50 %
Step	17	(1 to 17)
Note: initially, we have equilibrium in the sense that expected inflation is equal to actual inflation		

To access this section of the spreadsheet, the user clicks on the following link:

FRACBANK.XLS - 'Summary'!a1

All entries are driven from earlier calculations in the spreadsheet and are reproduced here for discussion purposes. The *Base scenario* column provides the results of the base or reference run. The numbers in this column are entered by hand after the

base scenario run. As policy runs are conducted, they will provide the base line against which the results of the policy runs can be compared. The results of the policy runs will show in the *Final* column. If the user changes the base scenario, the entries in the *Base scenario* column need to be adjusted to reflect the results of the new base or reference run before any policy run is conducted.

The model, as shown in Figure 15, is in equilibrium. Equilibrium exists in the sense that calculated inflation as the basis of the Phillip's curve is equal to actual inflation, aggregate demand growth equals actual output growth, and the real exchange rate change is zero.

CHAPTER 3

Model Guide

3.1.   Introduction

This guide discusses the application and use of the model with relation to principles and intermediate courses in macroeconomics. The document is intended to provide the user with the tools and ideas to explain, present, and model the money creation process and determine its effects on the economy. It is suggested that prior to the manipulation of data in the model a copy of the spreadsheet be made to keep as a backup.

When working through the following scenarios, the user should keep a printout of the *Basic Assumption, Money Creation Process*, and the *Summary Results* screens. Printouts allow for easy comparison and analysis of the changes that are made to the model.

There are six scenarios discussed in this section. Each scenario deals with a different aspect of monetary policy. The user is encouraged to define and develop other scenarios outside of those mentioned here.

The scenarios are designed to expand on the base scenario presented earlier in this document. The model requires that all transactions be made reasonably close to the assumptions of the base scenario. For instance, the $12 billion bond transaction that appears in the base scenario (along with the required reserve ratio, excess-reserve ratio,

and cash ratio) ensures that the model is in equilibrium initially. Expansionary monetary policy should be entered as bond purchases that are greater than $12 billion. Contractionary monetary policy should be entered as bond purchases that are less than $12 billion. Variations of the required reserve, excess reserve, and cash holdings can also be used to simulate monetary expansion or contraction.

3.2. Scenario 1 – Central Bank Engages in Expansionary Monetary Policy by Buying bonds

3.2.1. Introductory Level

The Fed makes purchases of government bonds on the open market. In this example, it purchases $15 billion in bonds, slightly more than the $12 billion of the base scenario. The monetary base increases by an equal amount.

Of the three major methods available to the Fed to manipulate the economy (open-market operations, changes in reserve requirements, and discount rate), the use of open-market operations is the most common.

The Fractional Reserve model should be activated by clicking on the hyperlink FRACBANK.XLS and the fifteen billion-dollar transaction should be entered as a 15 in the *Bond Transaction* column.

Figure 16 - Assumptions – Scenario 1

Fractional Reserve Banking					
Basic Assumptions					
Central Bank Assets	$ bill.	Transaction	Central Bank Liabilities	$ bill.	
Discount Loans	$ 2		Currency	$ 457	
Bond Holdings	$ 459	$ 15.0	Bank Reserves	$ 37	
FC Holdings	$ 17	$ -	Liability Other	$ 9	
Gold Holdings	$ 11	$ -	Total Liabilities	$ 503	
Assets Other	$ 25		Central Bank Capital	$ bill.	
Total Assets	$ 514		Total Capital	$ 11	
Banking Variables	%		Total Liabilities and Capital	$ 514	
Res Dep Ratio	10.00		Economy	$ bill.	
Excess Res.	7.50		Market Bond Supply	$ 5,745	
Public Preferences	%		Initial M1	$ 1,081	
Cash Holdings	14.19		Initial Financial Wealth	$ 6,826	
Step	0	(1 to 17)			

The Step Counter should be set to 0 (zero). To begin modeling, the user should click on the increment counter located to the left of the step number. As the counter increments, a description appears in the gray area below the counter. These descriptions reflect the action that has just taken place.

3.2.1.1. Scenario 1 - Step 1

The Central Bank purchases $15 billion dollars worth of bonds on the open-market. It pays for the bonds by check. The purchase is conducted by bond dealers in New York. The bonds are booked on the asset side of the Central Bank's balance sheet.

Figure 17 - Central Bank Balance Sheet – Scenario 1 – Step 1

Central Bank Balance Sheet							
Changes ($ bill.)				**Levels ($ bill.)**			
Assets		*Liabilities*		*Assets*		*Liabilities*	
DL	$ -	Currency	$ -	DL	$ 2.04	Currency	$ 457.47
Bonds	$ 15.00	Bank Res.		Bonds		Bank Res.	
		Bank A $	-	initial $	458.56	initial $	36.96
		$	-	final $	-	final $	-
		Bank B $	-				
FC	$ -	$	-	FC			
		Bank C $	-	initial $	17.05		
		$	-	final $	-		
Gold	$ -	Bank D $	-	Gold		Capital	$ 10.65
				initial $	11.05		
				final $	-		
				Other $	25.24	Other	$ 8.84
Sum	$ 15.00	Sum	$ -	Sum Initial $	513.92	Sum Initial	$ 513.92
Step		1	(1 to 17)	Sum Final $	-	Sum Final	$ -

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3.2.1.2. Scenario 1 - Step 2

The check for the purchase of the bond is deposited by the economic agent who sold the bonds in bank A. The demand deposits of Bank A rise by the amount of the deposit.

Figure 18 - Individual Bank T Accounts – Scenario 1 – Step 2

T Accounts of Individual Banks (Changes in $ bill.)							
Bank A Balance Sheet				**Bank B Balance Sheet**			
Assets		*Liabilities*		*Assets*		*Liabilities*	
Cash	$ -	DD	$ 15.00	Cash	$ -	DD	$ -
Res.	$ -		$ -	Res.	$ -		$ -
of which VExRs	$ -			of which VExRs	$ -		
	$ -	DD-Loan	$ -		$ -	DD-Loan	$ -
Loans	$ -		$ -	Loans	$ -		$ -
Sum	$ -		$ 15.00		$ -		$ -
Step		2	(1 to 17)	**Note: VExRs = Voluntary Excess Reserves**			
Bank C Balance Sheet				**Bank D Balance Sheet**			
Assets		*Liabilities*		*Assets*		*Liabilities*	
Cash	$ -	DD	$ -	Res.	$ -	DD	$ -
Res.	$ -		$ -				
of which VExRs	$ -						
	$ -	DD-Loan	$ -				
Loans	$ -		$ -				
Sum	$ -		$ -		$ -		$ -

3.2.1.3. Scenario 1 - Step 3

Bank A takes the check and sends it to the Fed for the purpose of cashing it. As the Fed receives the check, it credits bank A's account with these additional reserves. This balances with the bonds that the Fed has bought and that show up on the asset side of the Fed's balance sheet.

Figure 19 - Central Bank Balance Sheet – Scenario 1 – Step 3

Central Bank Balance Sheet									
Changes ($ bill.)					Levels ($ bill.)				
Assets		Liabilities			Assets			Liabilities	
DL	$ -	Currency	$	-	DL	$	2.04	Currency	$ 457.47
Bonds	$ 15.00	Bank Res.			Bonds			Bank Res.	
		Bank A $	15.00			initial $	458.56	Initial $	36.96
		$	-			final $	-	Final $	-
		Bank B $	-						
FC	$ -	$	-		FC				
		Bank C $	-			initial $	17.05		
		$	-			final $	-		
Gold	$ -	Bank D $	-		Gold			Capital	$ 10.65
						initial $	11.05		
						final $	-		
					Other	$	25.24	Other	$ 8.84
Sum	$ 15.00	Sum	$	15.00	Sum Initial	$	513.92	Sum Initial	$ 513.92
Step			3	(1 to 17)	Sum Final	$	-	Sum Final	$ -

3.2.1.4. Scenario 1 - Step 4

The Fed informs bank A of its increase in reserves. Bank A now books the reserves on the asset side of its balance sheet. Bank A's assets and liabilities are now equal.

Figure 20 - Individual Bank T Accounts – Scenario 1 – Step 4

T Accounts of Individual Banks (Changes in $ bill.)							
Bank A Balance Sheet				*Bank B Balance Sheet*			
Assets		*Liabilities*		*Assets*		*Liabilities*	
Cash	$ -	DD	$ 15.00	Cash	$ -	DD	$ -
Res.	$ 15.00		$ -	Res.	$ -		$ -
of which VExRs	$ -			of which VExRs	$ -		
	$ -	DD-Loan	$ -		$ -	DD-Loan	$ -
Loans	$ -		$ -	Loans	$ -		$ -
Sum	$ 15.00		$ 15.00		$ -		$ -
Step		4	(1 to 17)	**Note: VExRs = Voluntary Excess Reserves**			
Bank C Balance Sheet				*Bank D Balance Sheet*			
Assets		*Liabilities*		*Assets*		*Liabilities*	
Cash	$ -	DD	$ -	Res.	$ -	DD	$ -
Res.	$ -		$ -				
of which VExRs	$ -						
	$ -	DD-Loan	$ -				
Loans	$ -		$ -				
Sum	$ -		$ -		$ -		$ -

3.2.1.5. Scenario 1 - Summary of Money Creation Process – 1st Round

Step 4 marks the end of the first round of money creation in the summary table (Summary of Money Creation Process – After 1 round). Note that the monetary base (MB) and monetary supply (M1) have now increased.

Figure 21 - M1 Summary – Scenario 1 – 1st Round

Action	Changes in $ bill.			Levels in $ bill.		Implied Money
	MB	M1	Total Res.	MB	M1	Multiplier
In old equil.				$ 494.43	$ 1,080.90	
after 1 round	$ 15.00	$ 15.00	$ 15.00	$ 509.43	$ 1,095.90	
after 2 rounds	$ -	$ -	$ -	$ -	$ -	
after 3 rounds	$ -	$ -	$ -	$ -	$ -	
after 4 rounds	$ -	$ -	$ -	$ -	$ -	
In new equil.	$ -	$ -		$ -	$ -	0.00
Step		4	(1 to 17)			

3.2.1.6. Scenario 1 - Step 5

Bank A reviews its financial situation. Given the value of its deposits, it can raise the amount of loans it wishes to make. After depositors have withdrawn some cash, the bank can loan out its reserve amount less required reserves and what it wants to hold as excess reserves. The bank then creates new loans that appear in the balance sheet.

Figure 22 - Individual Bank T Accounts – Scenario 1 – Step 5

T Accounts of Individual Banks (Changes in $ bill.)							
Bank A Balance Sheet				*Bank B Balance Sheet*			
Assets		*Liabilities*		*Assets*		*Liabilities*	
Cash	$ (2.13)	DD	$ 15.00	Cash	$ -	DD	$ -
Res.	$ 15.00		$ (2.13)	Res.	$ -		$ -
of which VExRs	$ 0.97			of which VExRs	$ -		
	$ -	DD-Loan	$ 10.62		$ -	DD-Loan	$ -
Loans	$ 10.62		$ -	Loans	$ -		$ -
Sum	$ 23.49		$ 23.49		$ -		$ -
Step			5 (1 to 17)	**Note: VExRs = Voluntary Excess Reserves**			
Bank C Balance Sheet				*Bank D Balance Sheet*			
Assets		*Liabilities*		*Assets*		*Liabilities*	
Cash	$ -	DD	$ -	Res.	$ -	DD	$ -
Res.	$ -		$ -				
of which VExRs	$ -						
	$ -	DD-Loan	$ -				
Loans	$ -		$ -				
Sum	$ -		$ -		$ -		$ -

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3.2.1.7. Scenario 1 – Step 6

The borrower writes a check in the amount of the loan from bank A as part of a
purchase. The seller receives the check and deposits it in bank B. Demand deposits in
bank B increase by the deposited amount.

Figure 23 - Individual Bank T Accounts – Scenario 1 – Step 6

T Accounts of Individual Banks (Changes in $ bill.)							
Bank A Balance Sheet				**Bank B Balance Sheet**			
Assets		*Liabilities*		*Assets*		*Liabilities*	
Cash	$ (2.13)	DD	$ 15.00	Cash	$ -	DD	$ 10.62
Res.	$ 15.00		$ (2.13)	Res.	$ -		$ -
of which VexRs	$ 0.97			of which VExRs	$ -		
	$ -	DD-Loan	$ 10.62		$ -	DD-Loan	$ -
Loans	$ 10.62		$ -	Loans	$ -		$ -
Sum	$ 23.49		$ 23.49		$ -		$ -
Step		6	(1 to 17)	Note: VExRs = Voluntary Excess Reserves			
Bank C Balance Sheet				**Bank D Balance Sheet**			
Assets		*Liabilities*		*Assets*		*Liabilities*	
Cash	$ -	DD	$ -	Res.	$ -	DD	$ -
Res.	$ -		$ -				
of which VExRs	$ -						
	$ -	DD-Loan	$ -				
Loans	$ -		$ -				
Sum	$ -		$ -		$ -		$ -

3.2.1.8. Scenario 1 – Step 7

Bank B sends the check to the Fed for clearing. The Fed debits bank A's account by the amount of the check. The Fed then credits bank B's account by the amount of the check.

Figure 24 - Central Bank Balance Sheet – Scenario 1 – Step 7

Central Bank Balance Sheet											
Changes ($ bill.)						*Levels ($ bill.)*					
Assets		*Liabilities*				*Assets*			*Liabilities*		
DL	$ -	Currency	$	-		DL	$	2.04	Currency	$	457.47
Bonds	$ 15.00	Bank Res.				Bonds			Bank Res.		
		Bank A $		15.00			initial $	458.56		initial $	36.96
			$	(10.62)			final $	-		final $	-
		Bank B $		10.62							
FC	$ -		$	-		FC					
		Bank C $		-			initial $	17.05			
			$	-			final $	-			
Gold	$ -	Bank D $		-		Gold			Capital	$	10.65
							initial $	11.05			
							final $	-			
						Other	$	25.24	Other	$	8.84
Sum	$ 15.00	Sum	$	15.00		Sum Initial	$	513.92	Sum Initial	$	513.92
Step			7	(1 to 17)		Sum Final	$	-	Sum Final	$	-

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3.2.1.9. Scenario 1 – Step 8

The Fed then sends the check back to bank A with a notice that its account has been debited. Bank A has to update its accounts by debiting reserves and demand deposits by the amount of the check, since the borrower has withdrawn all of the borrowed money. Bank B needs to raise its reserves by the amount of the deposit.

Figure 25 - Individual Bank T Accounts – Scenario 1 – Step 8

T Accounts of Individual Banks (Changes in $ bill.)							
Bank A Balance Sheet				**Bank B Balance Sheet**			
Assets		*Liabilities*		*Assets*		*Liabilities*	
Cash	$ (2.13)	DD	$ 15.00	Cash	$ -	DD	$ 10.62
Res.	$ 15.00		$ (2.13)	Res.	$ 10.62		$ -
of which VExRs	$ 0.97			of which VExRs	$ -		
	$ (10.62)	DD-Loan	$ 10.62		$ -	DD-Loan	$ -
Loans	$ 10.62		$ (10.62)	Loans	$ -		$ -
Sum	$ 12.87		$ 12.87		$ 10.62		$ 10.62
Step		8	(1 to 17)	**Note: VExRs = Voluntary Excess Reserves**			
Bank C Balance Sheet				**Bank D Balance Sheet**			
Assets		*Liabilities*		*Assets*		*Liabilities*	
Cash	$ -	DD	$ -	Res.	$ -	DD	$ -
Res.	$ -		$ -				
of which VExRs	$ -						
	$ -	DD-Loan	$ -				
Loans	$ -		$ -				
Sum	$ -		$ -		$ -		$ -

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3.2.1.10. Scenario 1 - Summary of Money Creation Process – 2nd Round

Step 8 marks the end of the second round. Inside money has been created during this round. The monetary base (MB) is the same as after the end of the first round, but the money supply (M1) has risen. The *Summary of Money Creation Process* below details the current position.

Figure 26 - M1 Summary – Scenario 1 – 2nd Round

Summary of Money Creation Process									
Action	**Changes in $ bill.**						**Levels in $ bill.**		**Implied Money**
	MB		**M1**		**Total Res.**		**MB**	**M1**	**Multiplier**
In old equil.							$ 494.43	$ 1,080.90	
after 1 round	$	15.00	$	15.00	$	15.00	$ 509.43	$ 1,095.90	
after 2 rounds	$	15.00	$	25.62	$	12.87	$ 509.43	$ 1,106.52	
after 3 rounds	$	-	$	-	$	-	$ -	$ -	
after 4 rounds	$	-	$	-	$	-	$ -	$ -	
In new equil.	$	-	$	-			$ -	$ -	0.00
Step			8		(1 to 17)				

3.2.1.11. Scenario 1 - Steps 9 through 17

Steps 9 through 17 take the money creation process through banks B, C, and D. The steps the model takes in each process are the same as those discussed in steps 5 through 8. The student should review each of these steps, using the description generated on the *Fractional Reserve Example* sheet. Screens will not be generated to display steps 9 through 17; instead, the process will be described.

Scenario 1 – Step 9

Bank B reviews its financial situation. Given the value of its deposits, it can raise the amount of loans it wishes to make. It will loan out its reserve amount less required

reserves and less any amount of voluntary excess reserves. The bank creates new loans that appear in the balance sheet.

Scenario 1 – Step 10

The borrower writes a check in the amount of the loan from bank B as part of a purchase. The seller receives the check and deposits it in bank C. Demand deposits in bank C increase by the deposited amount.

Scenario 1 - Step 11

Bank C sends the check to the Fed for clearing. The Fed debits bank B's account by the amount of the check. The Fed then credits bank C's account by the amount of the check.

Scenario 1 - Step 12

The Fed then sends the check back to bank B with the notice that its account has been debited. Bank B has to update its accounts by dropping reserves and demand deposits by the amount of the check, since the borrower has withdrawn all of the borrowed money from his check account. Bank C also has some accounting to do. It needs to raise its reserves by the amount of the deposit.

Scenario 1 - Summary of Money Creation Process – 3rd Round

Step 12 marks the end of the third round. Inside money has been created during this round. The monetary base (MB) has not changed and the money supply (M1) has risen. The Summary of Money Creation Process gives the exact position.

Scenario 1 - Step 13

Bank C reviews its financial situation. Given the value of its deposits, it can raise the amount of loans it wishes to make. It will loan out its reserve amount less required reserves and less any amount it wants to hold as voluntary excess reserves. The bank creates new loans that appear in the balance sheet.

Scenario 1 - Step 14

The borrower writes the check in the amount of the loan from bank C as part of a purchase. The seller receives the check and deposits it in bank D. Demand Deposits in bank D increase by the deposited amount.

Scenario 1 - Step 15

Bank D sends the check to the Fed for clearing. The Fed debits bank C's account by the amount of the check. The Fed then credits bank D's account by the amount of the check.

Scenario 1 - Step 16

The Fed then sends the check back to bank C with the notice that its account has been debited. Bank C has to update its accounts by dropping reserves and demand deposits by the amount of the check, since the borrower has withdrawn all of the borrowed money from his checking account. Bank D also has some accounting to do. It needs to raise its reserves by the amount of the deposit.

Scenario 1 - Summary of Money Creation Process – 4th Round

Step 16 marks the end of the fourth round. Inside money has been created during this round. The monetary base (MB) has not changed and the money supply (M1) has increased. The Summary of Money Creation Process presents the current position.

3.2.1.12. Scenario 1 - Summary of Money Creation Process - Final

When the model reaches step 17, it displays the final equilibrium.

Figure 27 - M1 Summary – Scenario 1 – Final Round

Action	Changes in $ bill.			Levels in $ bill.		Implied Money
	MB	M1	Total Res.	MB	M1	Multiplier
In old equil.				$ 494.43	$ 1,080.90	
after 1 round	$ 15.00	$ 15.00	$ 15.00	$ 509.43	$ 1,095.90	
after 2 rounds	$ 15.00	$ 25.62	$ 12.87	$ 509.43	$ 1,106.52	
after 3 rounds	$ 15.00	$ 33.14	$ 11.36	$ 509.43	$ 1,114.04	
after 4 rounds	$ 15.00	$ 38.46	$ 10.30	$ 509.43	$ 1,119.36	
In new equil.	$ 15.00	$ 54.04		$ 509.43	$ 1,134.94	3.60
Step		17	(1 to 17)			

(Table title: Summary of Money Creation Process)

It can be seen from the final results in Figure 27 that:

- The Fed increased the monetary base by an initial $15 billion.

- The banking system took that increased monetary base and through the loan creation process increased M1 from $1,080.90 to $1,134.94, an increase of $54.04 billion.

- The money multiplier remains at 3.60, the same as in the base scenario.

3.2.1.13. The Equation of Exchange

The equation of exchange links the percentage change in the money supply (*M*1) to inflation expectations.

Figure 28 - Equation of Exchange – Scenario 1

M1, the Equation of Exchange and Inflation Expectations	
Variables	*$ bill.*
Change in Monetary Base	$ 15
New M1 money supply level	$ 1,135
New Bond supply level	$ 5,730
Percentage Change in M1	5.00 %
Assumed Percentage Change in Y	2.50 %
Assumed Percentage Change in Velocity	1.00 %
Expected Percentage Change in Price (Expected inflation)	3.50 %
Step 17 (1 to 17)	

The Fed's purchase of $15 billion in bonds has changed the monetary base (MB) by an equal amount. M1 has risen from its original $1,080.90 billion to $1,135.00 billion, a change of 5.00 percent as compared to 4 percent in the base scenario. Inflation is expected to rise to 3.5 percent from the base scenario expectation of 2.5 percent.

3.2.1.14. The Impact of Money on Interest

This section of the model determines several interest rates. The short-run interest rate is calculated so as to clear the bond and money markets. The expected short-run interest rate takes into account inflation expectations based on the equation of exchange. The connection to the long-run interest rate is provided by the yield curve.

Figure 29 - Interest Rates – Scenario 1

The Impact of Money on Interest Rates						
(short and long run)						
Share of bonds in fin. wealth			**Bond demand as a function of the interest rate**			
Equation 1	0.83	=	0.828556205	+	0.0015	**i**
Share of money in fin. Wealth			**Money demand as a function of the interest rate**			
Equation 2	0.17	=	0.171444	-	0.0015	**i**
Adding up Constraint	1.00	=	1.000000	+	0.0000	
Equation 1 equilibrium interest rate					4.07	%
Equation 2 equilibrium interest rate					4.07	%
Term Structure						
Implied Long Run i		Current Short Run i		Expected Short Run i		
4.97 %		4.07 %		5.07 %		
Note: the expected short-run rate is calculated as the actual nominal rate,						
plus the difference between expected inflation rate, and actual inflation rate.						
Step		17	(1 to 17)			

The increase in the money supply by 5 percent changes the nominal short-run interest rate. It decreases from 5 percent in the base scenario to 4.07 percent. The expected short-run rate rises slightly compared to the base scenario.

The effect on the long-run interest rate is calculated using the term structure and a ten-year time horizon. This calculation shows that the implied long-run interest rate has dropped from 5.00 percent to 4.97 percent. The real long-run interest rate will be discussed in the summary section.

3.2.2. Intermediate Level

This section deals with intermediate economic issues covered by the model and is more suited to those students that have covered the basic introductory courses to money in the economy.

3.2.2.1. The Impact of Money on Nominal and Real Exchange Rates

Figure 30 shows the relationship between money and exchange rates. The expected rate of depreciation of the currency drops from 1.5 percent to 0.6 percent because of the expansionary monetary policy. The real exchange rate, in turn, shows an appreciation of 0.93 percent. This real appreciation has the effect of making local goods more expensive on the international market and foreign goods less expensive on the local market. One would expect this to result in a decrease in net exports.

Figure 30 - Exchange Rates – Scenario 1

The Impact of Money on Nominal and Real Exchange Rates	
Definitions	**Values**
i - Domestic Short-run Nominal Interest Rate, percent	4.07
Assumed Foreign Real Interest Rate, percent	2.50
if - Foreign Short Run Nominal Interest Rate, percent	3.50
(i - if) – Expected Rate of Depreciation of Domestic Currency, percent	0.57
Assumed Foreign Inflation Rate, percent	1.00
Assumed Domestic Inflation Rate, percent	2.50
Calculation of Real Exchange Rate	
Implied percentage change of real exchange rate = (% chng in e + % chng in p - % chng in pf)	0.93
Note: assuming that expected rates equal actual rates on average (rational expectations are assumed here).	
Step	17 (1 to 17)

3.2.2.2. The Impact of Money on the Real Sector - Consumption

Expansionary monetary policy increases the level of consumption within the economy. In the base scenario, consumption growth is at 2.50 percent. Monetary expansion puts consumption growth at 2.73 percent. This is brought about by the interest rate effect.

Figure 31 - Consumption – Scenario 1

Consumption		
Income Growth	*Interest Rate Effect*	*Consumption Growth*
2.50 %	0.23 %	2.73 %
Step	17 (1 to 17)	

3.2.2.3. The Impact of Money on the Real Sector - Investment

Changes in interest rates also affect investment. In Figure 32, investment growth increases from the base scenario 3.75 percent to 4.26 percent. This is due to changes in the real long-run interest rate being lower.

Figure 32 - Investment – Scenario 1

Investment		
Real Long Run Rate	1.47 %	
Income Growth	*Interest Rate Effect*	*Investment Growth*
3.75 %	0.51 %	4.26 %
Step	17 (1 to 17)	

3.2.2.4. The Impact of Money on the Real Sector – Net Exports

The real exchange rate has appreciated by 0.93 percent because of the predicted interest rate and nominal exchange rate changes. Domestic products are now more expensive when compared to foreign products. When domestic products are more expensive than foreign products, exports decrease. Export growth decreases to 2.41 percent. There is a corresponding increase in import growth to 3.84 percent.

Figure 33 - Net Exports – Scenario 1

Net Exports			
Assumed Foreign Output Growth		2.50	
Exports	*Foreign Inc Growth*	*Exchange Rate Effect*	*Export Growth*
	2.50 %	-0.09 %	2.41 %
Imports	*Income Growth*	*Exchange Rate Effect*	*Import Growth*
	3.75 %	0.09 %	3.84 %
Step	17	(1 to 17)	

3.2.2.5. Growth of Aggregate Demand

Growth in aggregate demand is a weighted average of the individual aggregate demand components. Growth of Aggregate Demand stands now at 2.70 percent, somewhat above the 2.5 percent of the base scenario.

Figure 34 - Aggregate Demand – Scenario 1

Weighting Scheme for Aggregate Demand	
Consumption	4.5
Investment	1
Exports	1
Government	1.5
Imports	1
Total Aggregate Demand	*7*
Growth of Aggregate Demand	
Share of C x Growth of C	1.76
Share of I x Growth of I	0.61
Share of X x Growth of X	0.34
Share of G x Growth of G	0.54
Share of M x Growth of M	0.55
Growth of Aggregate Demand	*2.70*
Step	17 (1 to 17)

3.2.2.6. Phillips Curve – Inflation Rate

The model assumes an initial inflation rate of 2.50 percent. The new inflation rate is 3.19 percent. Random supply shocks have been ignored in this scenario. The combination of the increase in Aggregate Demand and the expected inflation effect determines the new inflation rate.

Figure 35 - Phillip's Curve – Scenario 1

Phillips Curve	
Variable	*Result*
Aggregate Demand Vs Aggregate Supply	0.49 %
Expected Inflation Effect	2.70 %
Random Supply Shock	0 %
New Inflation Rate	*3.19 %*
Step	17 (1 to 17)

3.2.2.7. Summary

The summary table below provides the results of this scenario and compares them to those of the base scenario.

Figure 36 - Summary – Scenario 1

Summary Table with Basic Assumptions and Results		
Assumed Exogenous Growth Rates		
Output		2.50 %
Foreign Output		2.50 %
Levels and Growth Rates	*Base scenario*	*Final*
M1 growth	4.00 %	5.00 %
nominal short run interest rate	5.00 %	4.07 %
nominal long run interest rate	5.00 %	4.97 %
real long run interest rate	2.50 %	1.47 %
inflation (Phillips curve)	2.50 %	3.19 %
expected depreciation	1.50 %	0.57 %
percent change in real e	0.00 %	0.93 %
Resulting percentage changes	*Base scenario*	*Final*
Consumption	2.50 %	2.73 %
Investment	3.75 %	4.26 %
Exports	2.50 %	2.41 %
Imports	3.75 %	3.84 %
Aggregate demand	2.50 %	2.70 %
Step	17 (1 to 17)	

Expansionary monetary policy (which is the outcome of an open-market purchase on behalf of the Fed) affects the economy in many ways. There is a significant decrease in the nominal short-run interest rate.   The nominal long-run interest rate decreases slightly. The real long-run interest rate decreases while the inflation rate rises. The rate of growth of consumption and investment rises. The rate of growth of exports decreases while the rate of growth of imports increases. The rate of growth of aggregate demand

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also increases. According to the Phillip's curve, inflation in the next period rises above the base scenario level of 2.5 percent.

3.3.   Scenario 2 – Banks Increase Excess Reserves

3.3.1.   Introductory Level

Banks decide to increase excess reserves from 7.5 percent to 10 percent of demand deposits. An increase in excess reserves has similar results as a tightening of monetary policy. Banks may hold these additional funds for several reasons. They may expect additional transactions that might deplete reserves to a point where they would need to borrow to cover daily transactions. Banks can plan to hold extra reserves to cover this contingency. Banks may also create fewer loans as their perceived risk increases.

The banks in our model are assumed to raise the reserve ratio to 10 percent. In modeling this scenario, each of the steps will not be described as was done in Scenario 1. Rather, summary screens will be used to see how and where changes occur.

The first step is to enter 10.00 in the *'Fractional Reserve Example' – cell C13 Excess Res.* (Excess Reserves Held by Banks) section of *Banking Variables* (see arrow). While this entry is made as a whole number, it will appear as a percentage throughout the model. Then, one should move through the step counter, reviewing the money creation process as before until the model reaches step 17.

Figure 37 - Assumptions – Scenario 2

Fractional Reserve Banking					
Basic Assumptions					
Central Bank Assets	$ bill.	Transaction	Central Bank Liabilities	$ bill.	
Discount Loans	$ 2		Currency	$ 457	
Bond Holdings	$ 459	$ 12.0	Bank Reserves	$ 37	
FC Holdings	$ 17	$ -	Liability Other	$ 9	
Gold Holdings	$ 11	$ -	Total Liabilities	$ 503	
Assets Other	$ 25		Central Bank Capital	$ bill.	
Total Assets	$ 514		Total Capital	$ 11	
Banking Variables	%		Total Liabilities and Capital	$ 514	
Res Dep Ratio	10.00		Economy	$ bill.	
Excess Res.	10.00		Market Bond Supply	$ 5,745	
Public Preferences	%		Initial M1	$ 1,081	
Cash Holdings	14.19		Initial Financial Wealth	$ 6,826	
Step	17	(1 to 17)			
When the process runs to completion, we have a new M1 and Money Multiplier that is based on the parameters that are in effect for the assumed changes.					

3.3.1.1. Scenario 2 – Summary of the Money Creation Process

The increase in excess reserves from 7.5 percent to 10 percent affects several areas of the summary process shown in Figure 38. M1, which expands by $43.24 billion in the base scenario, now only grows by $40.07 billion. The money multiplier is lower (3.34) than the original multiplier (3.60) because excess reserves have lowered the amount of loans, and the banks' ability to create inside money.

Figure 38 - M1 Summary – Scenario 2

Action	Changes in $ bill.			Levels in $ bill.		Implied Money
	MB	M1	Total Res.	MB	M1	Multiplier
In old equil.				$ 494.43	$ 1,080.90	
after 1 round	$ 12.00	$ 12.00	$ 12.00	$ 506.43	$ 1,092.90	
after 2 rounds	$ 12.00	$ 20.24	$ 10.30	$ 506.43	$ 1,101.14	
after 3 rounds	$ 12.00	$ 25.89	$ 9.13	$ 506.43	$ 1,106.79	
after 4 rounds	$ 12.00	$ 29.77	$ 8.32	$ 506.43	$ 1,110.67	
In new equil.	$ 12.00	$ 40.07		$ 506.43	$ 1,120.97	3.34
Step		17	(1 to 17)			

Summary of Money Creation Process (table title spanning header)

3.3.2. Intermediate Level

The summary table compares the results with those of the base scenario.

Figure 39 - Summary – Scenario 2

Summary Table with Basic Assumptions and Results		
Assumed Exogenous Growth Rates		
Output		2.50 %
Foreign Output		2.50 %
Levels and Growth Rates	**Base scenario**	**Final**
M1 growth	4.00 %	3.71 %
nominal short run interest rate	5.00 %	5.26 %
nominal long run interest rate	5.00 %	4.99 %
real long run interest rate	2.50 %	2.79 %
inflation (Phillips curve)	2.50 %	2.31 %
expected depreciation	1.50 %	1.76 %
percent change in real e	0.00 %	-0.26 %
Resulting percentage changes	**Base scenario**	**Final**
Consumption	2.50 %	2.44 %
Investment	3.75 %	3.61 %
Exports	2.50 %	2.53 %
Imports	3.75 %	3.72 %
Aggregate demand	2.50 %	2.45 %
Step	17	(1 to 17)

A reduction of loanable funds (which is the outcome of holding excess reserves) affects the economy in many ways. The nominal short-run interest rate rises while the nominal long-run interest rate decreases slightly. The real long-run interest rate rises and the inflation rate decreases. The rate of growth of consumption decreases, as does the rate of growth of investment. The rate of growth of exports goes up while the rate of growth of imports goes down because of the lower real exchange rate. The rate of growth in aggregate demand decreases.

When compared to the base scenario, it is easy to see how agents actions can reduce the intended outcome of the Fed. In this instance, excess reserves increased resulting in a slow down of growth in the economy.

3.4.   Scenario 3 – Public Increases Cash Holdings

3.4.1.   Introductory Level

In scenario 3, as in the base scenario, the Fed purchases $12 billion worth of bonds. The assumption is that cash holdings by the public will increase to 16.69 percent of demand deposits.

When cash preference changes, the supply of money is affected. A practical example of a change in preferences is the possibility that the public may hold excessive cash during December 1999 and January 2000. Concern that electronic cash and credit card systems might fail due to the year 2000 computer bug may change the public's cash preferences. During November and December 1999, the public may make large withdrawals of cash, just in case the credit card, and cash card systems will break down during the early part of the year 2000.

Changes in the public's expectations affect the amounts of cash that they carry. Currently, with the use of cash cards and electronic fund transfers, the public tends to carry less cash than they did in the past. Sudden changes in cash holdings can throw monetary policy off course. Assume that in January of the year 2000 the Fed increases the monetary base to sustain growth. If people react in a survivalist manner and hold more cash, the net effect on the economy will be vastly different from what the Fed expects.

An increase in cash holdings by the public has an effect similar to the Fed reducing its bond purchases. An increase in cash holdings by the public is also similar to banks holding more excess reserves.

The step counter should be set to 0 (zero) and cash holdings should be changed to 16.69. Bond Holdings must have a 12 entered to reflect the base scenario. The user can step through the counter to see the money creation process.

Figure 40 - Assumptions – Scenario 3

Fractional Reserve Banking					
Basic Assumptions					
Central Bank Assets	$ bill.	Transaction	Central Bank Liabilities	$ bill.	
Discount Loans	$ 2		Currency	$ 457	
Bond Holdings	$ 459	$ 12.0	Bank Reserves	$ 37	
FC Holdings	$ 17	$ -	Liability Other	$ 9	
Gold Holdings	$ 11	$ -	Total Liabilities	$ 503	
Assets Other	$ 25		Central Bank Capital	$ bill.	
Total Assets	$ 514		Total Capital	$ 11	
Banking Variables	%		Total Liabilities and Capital	$ 514	
Res Dep Ratio	10.00		Economy	$ bill.	
Excess Res.	7.50		Market Bond Supply	$ 5,745	
Public Preferences	%		Initial M1	$ 1,081	
Cash Holdings	16.69		Initial Financial Wealth	$ 6,826	
Step	0	(1 to 17)			

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3.4.1.1. Summary of Money Creation Process

If the money creation outcome is compared with that of the base scenario, one discovers that at each round the increase in M1 is lower than in the base scenario. The increases in M1 are lower because funds are being withheld by the public, and do not contribute to the loan process. The net effect is that, rather than creating $43.24 billion in M1, the model now only creates $40.96 billion. The money multiplier is lower (3.41) compared to the base scenario (3.6) because of the cash withdrawals.

Figure 41 - M1 Summary – Scenario 3

Action	Changes in $ bill.			Levels in $ bill.		Implied Money
	MB	M1	Total Res.	MB	M1	Multiplier
In old equil.				$ 494.43	$ 1,080.90	
after 1 round	$ 12.00	$ 12.00	$ 12.00	$ 506.43	$ 1,092.90	
after 2 rounds	$ 12.00	$ 20.25	$ 10.00	$ 506.43	$ 1,101.15	
after 3 rounds	$ 12.00	$ 25.92	$ 8.62	$ 506.43	$ 1,106.82	
after 4 rounds	$ 12.00	$ 29.81	$ 7.67	$ 506.43	$ 1,110.71	
In new equil.	$ 12.00	$ 40.96		$ 506.43	$ 1,121.86	3.41
Step		17	(1 to 17)			

3.4.2. Intermediate Level

The summary table below provides the results of this scenario and compares these to those of the base scenario.

Figure 42 - Summary – Scenario 3

Summary Table with Basic Assumptions and Results		
Assumed Exogenous Growth Rates		
Output		2.50 %
Foreign Output		2.50 %
Levels and Growth Rates	*Base scenario*	*Final*
M1 growth	4.00 %	3.79 %
nominal short run interest rate	5.00 %	5.19 %
nominal long run interest rate	5.00 %	5.00 %
real long run interest rate	2.50 %	2.71 %
inflation (Phillips curve)	2.50 %	2.36 %
expected depreciation	1.50 %	1.69 %
percent change in real e	0.00 %	-0.19 %
Resulting percentage changes	*Base scenario*	*Final*
Consumption	2.50 %	2.45 %
Investment	3.75 %	3.65 %
Exports	2.50 %	2.52 %
Imports	3.75 %	3.73 %
Aggregate demand	2.50 %	2.46 %
Step	17 (1 to 17)	

An increase in cash holdings reduces loanable funds, affecting the economy in many ways. The nominal short-run interest rate rises while the nominal long-run interest rate remains unchanged. The real long-run interest rate rises and inflation decreases. The growth of consumption decreases, as does the growth of investment. The growth of exports increases because of the depreciation in the real exchange rate. Domestic products are now cheaper on the foreign market. The rate of growth of imports decreases

because the lower real exchange rate makes foreign goods comparatively more expensive. The rate of growth in aggregate demand decreases.

When compared to the base scenario, it is easy to see how agents actions can reduce the intended outcome of the Fed. In this instance, cash holdings increase resulting in a slow down of growth in the economy.

3.5. Scenario 4 – Central Bank Engages in Contractionary Monetary Policy through Open Market Operations

3.5.1. Introductory Level

The base scenario had an initial bond purchase of $12 billion to expand the monetary base. In this scenario, the Fed wishes to purchase a smaller number of bonds than the base scenario.

In modeling this scenario, only the summary screens will be examined to demonstrate how and where changes occur, and to point out areas of interest.

This policy example is of interest as it portrays the methodology used by the Fed to tighten monetary policy. In the bond transaction section of Banking Variables (see arrow), 6.00 should be entered. The user then moves through the step counter reviewing the money creation process as before until the model reaches step 17.

Figure 43 - Assumptions – Scenario 4

<table>
<tr><td colspan="6">Fractional Reserve Banking</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td colspan="6">Basic Assumptions</td></tr>
<tr><td>Central Bank Assets</td><td>$ bill.</td><td>Transaction</td><td>Central Bank Liabilities</td><td>$ bill.</td><td></td></tr>
<tr><td>Discount Loans</td><td>$ 2</td><td></td><td>Currency</td><td>$ 457</td><td></td></tr>
<tr><td>Bond Holdings</td><td>$ 459</td><td>$ 6.0</td><td>Bank Reserves</td><td>$ 37</td><td></td></tr>
<tr><td>FC Holdings</td><td>$ 17</td><td>$ -</td><td>Liability Other</td><td>$ 9</td><td></td></tr>
<tr><td>Gold Holdings</td><td>$ 11</td><td>$ -</td><td>Total Liabilities</td><td>$ 503</td><td></td></tr>
<tr><td>Assets Other</td><td>$ 25</td><td></td><td>Central Bank Capital</td><td>$ bill.</td><td></td></tr>
<tr><td>Total Assets</td><td>$ 514</td><td></td><td>Total Capital</td><td>$ 11</td><td></td></tr>
<tr><td>Banking Variables</td><td>%</td><td></td><td>Total Liabilities   and Capital</td><td>$ 514</td><td></td></tr>
<tr><td>Res Dep Ratio</td><td>10.00</td><td></td><td>Economy</td><td>$ bill.</td><td></td></tr>
<tr><td>Excess Res.</td><td>7.50</td><td></td><td>Market Bond Supply</td><td>$ 5,745</td><td></td></tr>
<tr><td>Public Preferences</td><td>%</td><td></td><td>Initial M1</td><td>$ 1,081</td><td></td></tr>
<tr><td>Cash Holdings</td><td>14.19</td><td></td><td>Initial Financial Wealth</td><td>$ 6,826</td><td></td></tr>
<tr><td>Step</td><td>17</td><td>(1 to 17)</td><td></td><td></td><td></td></tr>
<tr><td colspan="6">When the process runs to completion, we have a new M1 and Money Multiplier that is
based on the parameters that are in effect for the assumed changes.</td></tr>
</table>

3.5.1.1. Summary of the Money Creation Process

A reduction in the number of bonds purchased to $6.0 billion causes the money supply to contract when compared to the base scenario. With reserve ratios set to a standard 10 percent. M1 rises by less than in the base scenario. The money multiplier is not affected.

Figure 44 - M1 Summary – Scenario 4

Action	Changes in $ bill.			Levels in $ bill.		Implied Money
	MB	M1	Total Res.	MB	M1	Multiplier
In old equil.				$ 494.43	$ 1,080.90	
after 1 round	$ 6.00	$ 6.00	$ 6.00	$ 500.43	$ 1,086.90	
after 2 rounds	$ 6.00	$ 10.25	$ 5.15	$ 500.43	$ 1,091.15	
after 3 rounds	$ 6.00	$ 13.25	$ 4.55	$ 500.43	$ 1,094.15	
after 4 rounds	$ 6.00	$ 15.38	$ 4.12	$ 500.43	$ 1,096.28	
In new equil.	$ 6.00	$ 21.62		$ 500.43	$ 1,102.52	3.60
Step		17	(1 to 17)			

3.5.2. Intermediate Level

The summary table below provides the results of this scenario and compares them to those of the base scenario.

Figure 45 - Summary – Scenario 4

Summary Table with Basic Assumptions and Results		
Assumed Exogenous Growth Rates		
Output		2.50 %
Foreign Output		2.50 %
Levels and Growth Rates	*Base scenario*	*Final*
M1 growth	4.00 %	2.00 %
nominal short run interest rate	5.00 %	6.86 %
nominal long run interest rate	5.00 %	5.06 %
real long run interest rate	2.50 %	4.56 %
inflation (Phillips curve)	2.50 %	1.12 %
expected depreciation	1.50 %	3.36 %
percent change in real e	0.00 %	-1.86 %
Resulting percentage changes	*Base scenario*	*Final*
Consumption	2.50 %	2.04 %
Investment	3.75 %	2.72 %
Exports	2.50 %	2.69 %
Imports	3.75 %	3.56 %
Aggregate demand	2.50 %	2.11 %
Step 17	(1 to 17)	
Note: initially, we have equilibrium in the sense that expected inflation is equal to actual inflation		

This paper will not discuss in detail the overall effect on the economy of these scenarios. Reference should be made to scenario 1 for content of that discussion, and attention should be given to Figure 45.

3.6.   Scenario 5 – Central Bank Wishes to Lower Interest Rates

3.6.1. Intermediate Level

This scenario encourages the student to develop a method by which the Fed can reach a given interest rate. For example, one can assume that the Fed wishes to reduce the nominal interest rate in the economy from 5 percent (the base scenario assumption) to 3.5 percent. What methods could be used to attain this goal?

The FOMC determines what needs to be done to meet the goals of the Fed. This scenario places the user in the position of the FOMC and asks what should be done.

The different methods of monetary policy available to the Fed have been discussed. The Fed can either change reserve requirements, purchase or sell bonds on the open-market, or modify the discount rate. This scenario equates to a "goal seeking" problem. Given an outcome, what steps must be taken to reach the goal? The model begins with the assumptions of the base scenario.

Figure 46 - Assumptions – Scenario 5

Fractional Reserve Banking					
Basic Assumptions					
Central Bank Assets	$ bill.	Transaction	Central Bank Liabilities	$ bill.	
Discount Loans	$ 2		Currency	$ 457	
Bond Holdings	$ 459	$ 12.0	Bank Reserves	$ 37	
FC Holdings	$ 17	$ -	Liability Other	$ 9	
Gold Holdings	$ 11	$ -	Total Liabilities	$ 503	
Assets Other	$ 25		Central Bank Capital	$ bill.	
Total Assets	$ 514		Total Capital	$ 11	
Banking Variables	%		Total Liabilities and Capital	$ 514	
Res Dep Ratio	10.00		Economy	$ bill.	
Excess Res.	7.50		Market Bond Supply	$ 5,745	
Public Preferences	%		Initial M1	$ 1,081	
Cash Holdings	14.19		Initial Financial Wealth	$ 6,826	
Step	17	(1 to 17)			
When the process runs to completion, we have a new M1 and Money Multiplier that is based on the parameters that are in effect for the assumed changes.					

Purchase of bonds has been set to 12 (the base scenario quantity) and the step counter has been set to 17. To gauge the final impact using the goal-seeking function within Excel, the step counter must be set to 17.

Once the cells have been set as stated above, one clicks on the tools menu of Excel and chooses "Goal Seek." A small Goal Seek Box will appear on the screen as shown below.

Figure 47 - Goal Seek – Scenario 5
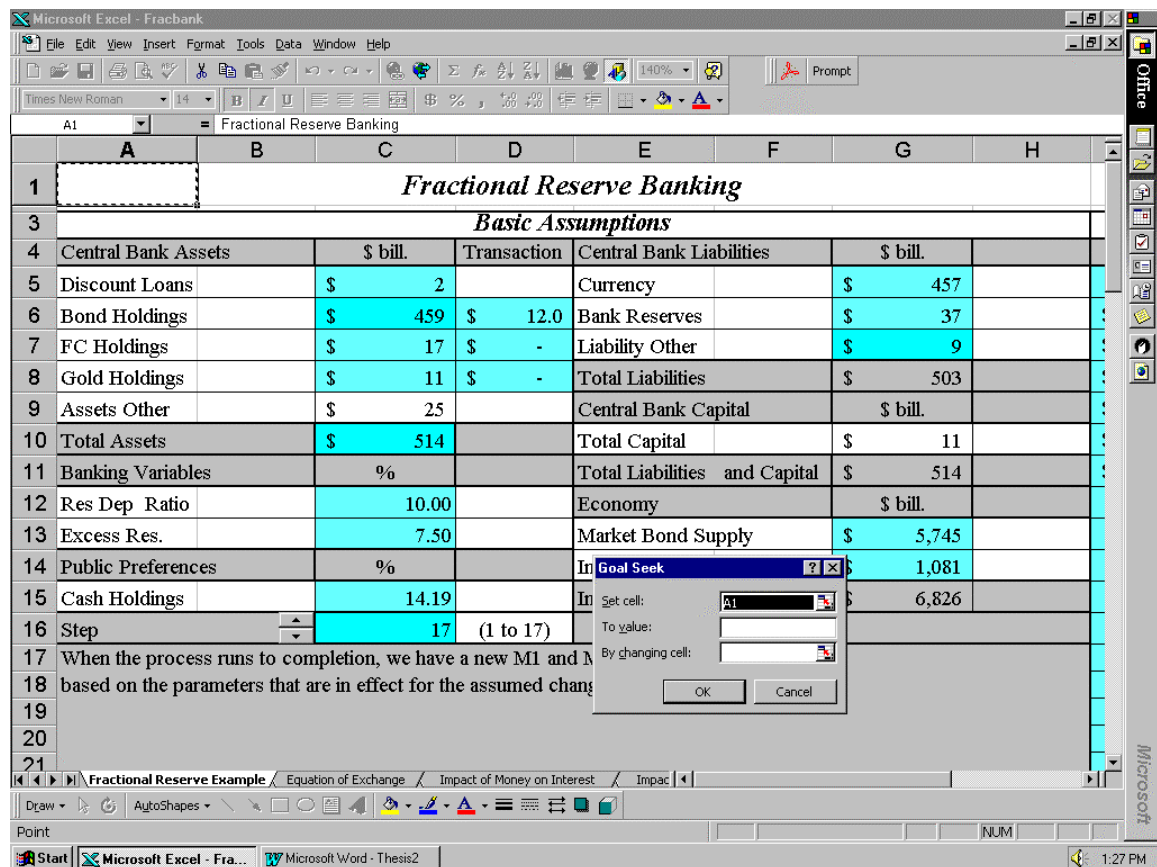
The goal-seeking function within Excel allows the user to choose a certain cell within the spreadsheet that needs to be set to a certain value. The goal-seeking option allows the user to:

- enter the cell to be changed

- enter the number to which it must be set

- select a cell that can be changed by the program in order to reach the goal.

The interest rate goal is set at 3.5 percent. In this example, bond holdings will be the policy tool to reach the goal.

Step 1 – Set Cell:

The *Set Cell* requires that the user choose the cell to be set equal to 3.5 percent. First, one should click on the *Set Cell* box so that it is highlighted. Then the user clicks on the sheet name *Impact of Money on Interest* to move to that portion of the worksheet. Once at that sheet, one clicks on cell D18 the *Current Short-run Interest Rate*. The selected cell should say 5.00 percent prior to any calculations. When the *enter key* is depressed, the screen will jump back to the *Fractional Reserve Example* screen, and the next entry is anticipated.

Step 2 – To Value:

The *To Value* portion of the *Goal Seek* screen allows the user select the goal that is to be sought. In this case, 3.5 (to represent 3.5 percent) should be entered.

Step 3 – By Changing:

At this point, the user decides what policy tools should be used to achieve the desired outcome. The model uses changes in the bond holdings of the central bank. An alternative policy tool could be a change in the *Reserve Deposit Ratio*. *D6* should be entered in the *By Changing Cell*. Once this entry is made, the screen will appear as follows:

Figure 48 - Goal Seek Entry – Scenario 5
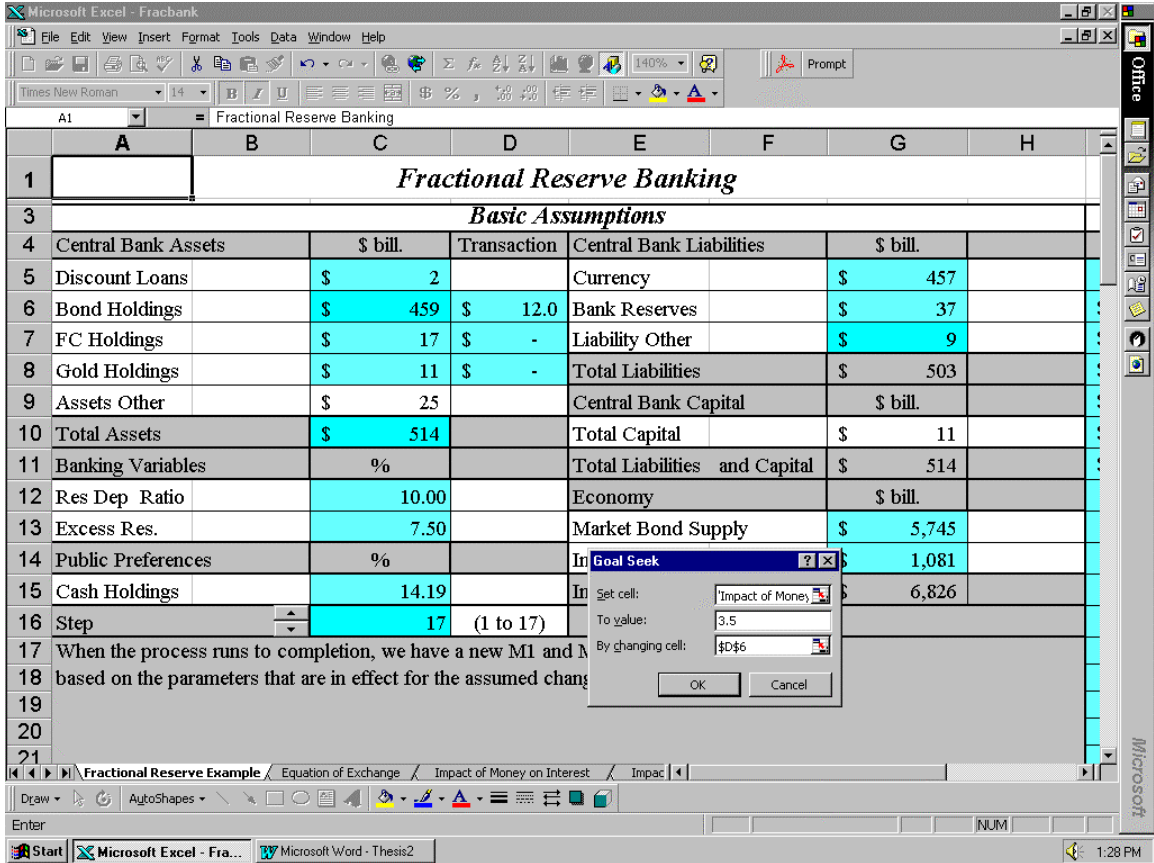
The Goal Seek Screen is now waiting for the selection of the *OK* button to determine the required value in the bond transaction field. When *OK* is clicked, the program will find a solution and display the following screen.

Figure 49 - Goal Seek Solution – Scenario 5
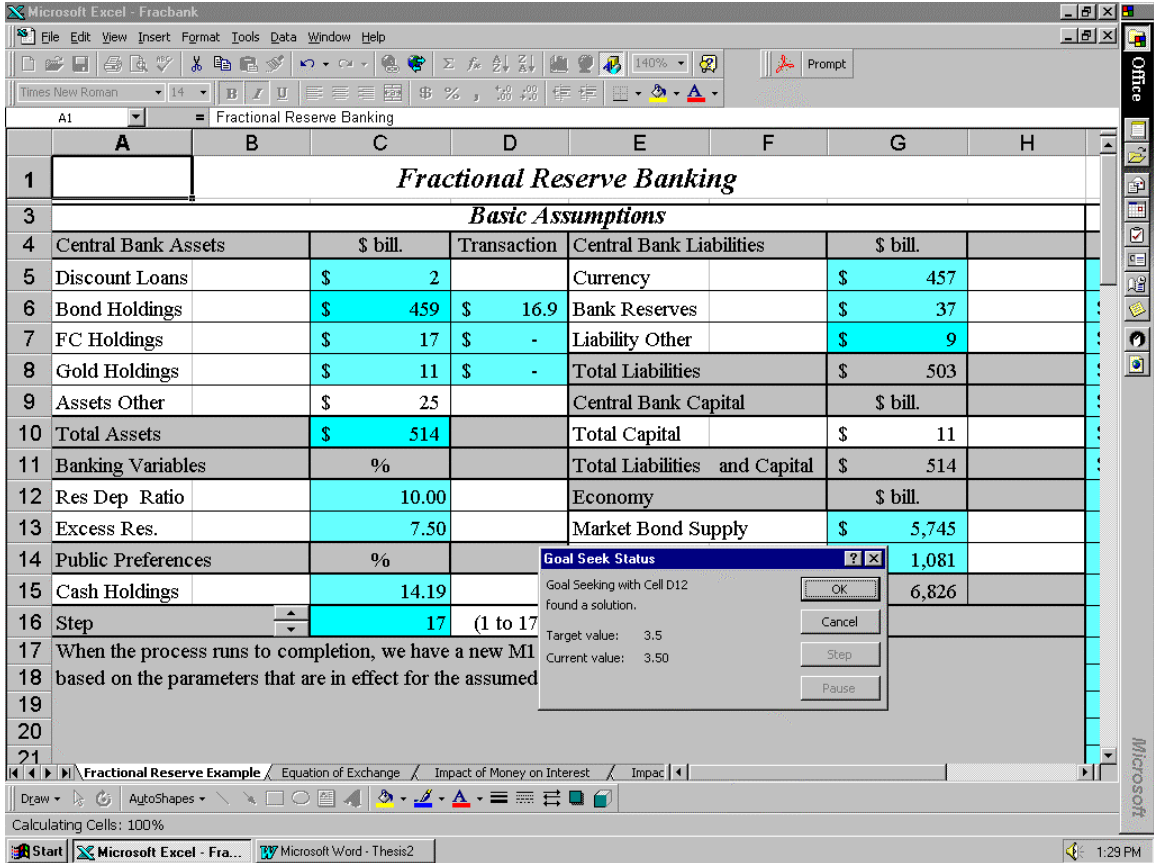
The message box indicates that Excel has found a solution that matches the target value of 3.5. When *OK* is chosen again, the Goal Seek Status box will disappear.

If a selection is made that cannot be calculated, the Goal Seek Status Box will indicate the error that has occurred. In most cases, the error should appear because of the system's inability to solve for the entered outcome. Changes that are very far from the base scenario outcome are very likely to trigger errors.

Figure 50 - Solution – Scenario 5

Fractional Reserve Banking					
Basic Assumptions					
Central Bank Assets	$ bill.	Transaction	Central Bank Liabilities	$ bill.	
Discount Loans	$ 2		Currency	$ 457	
Bond Holdings	$ 459	$ 16.9	Bank Reserves	$ 37	
FC Holdings	$ 17	$ -	Liability Other	$ 9	
Gold Holdings	$ 11	$ -	Total Liabilities	$ 503	
Assets Other	$ 25		Central Bank Capital	$ bill.	
Total Assets	$ 514		Total Capital	$ 11	
Banking Variables	%		Total Liabilities and Capital	$ 514	
Res Dep Ratio	10.00		Economy	$ bill.	
Excess Res.	7.50		Market Bond Supply	$ 5,745	
Public Preferences	%		Initial M1	$ 1,081	
Cash Holdings	14.19		Initial Financial Wealth	$ 6,826	
Step	17	(1 to 17)			
When the process runs to completion, we have a new M1 and Money Multiplier that is based on the parameters that are in effect for the assumed changes.					

In this case, the solver has selected $16.9 billion in bond purchases as the solution for reaching the 3.5 percent interest rate goal with open-market purchases.

The Summary screen below displays the overall effect on the levels and changes in the money supply. A rise in the monetary base of $16.9 billion raises M1 by $60.76 billion or 5.62 percent.

Figure 51 - M1 Summary – Scenario 5

Action	Changes in $ bill.			Levels in $ bill.		Implied Money
	MB	**M1**	**Total Res.**	**MB**	**M1**	**Multiplier**
In old equil.				$ 494.43	$ 1,080.90	
after 1 round	$ 16.86	$ 16.86	$ 16.86	$ 511.29	$ 1,097.76	
after 2 rounds	$ 16.86	$ 28.80	$ 14.47	$ 511.29	$ 1,109.70	
after 3 rounds	$ 16.86	$ 37.25	$ 12.78	$ 511.29	$ 1,118.15	
after 4 rounds	$ 16.86	$ 43.24	$ 11.58	$ 511.29	$ 1,124.14	
In new equil.	$ 16.86	$ 60.76		$ 511.29	$ 1,141.66	3.60
Step		17	(1 to 17)			

Summary of Money Creation Process (table title)

The summary table below provides the results of this scenario and compares them to those of the base scenario.

Figure 52 - Summary – Scenario 5

Summary Table with Basic Assumptions and Results		
Assumed Exogenous Growth Rates		
Output		2.50 %
Foreign Output		2.50 %
Levels and Growth Rates	**Base scenario**	**Final**
M1 growth	4.00 %	5.62 %
nominal short run interest rate	5.00 %	3.50 %
nominal long run interest rate	5.00 %	4.96 %
real long run interest rate	2.50 %	0.84 %
inflation (Phillips curve)	2.50 %	3.62 %
expected depreciation	1.50 %	0.00 %
percent change in real e	0.00 %	1.50 %
Resulting percentage changes	**Base scenario**	**Final**
Consumption	2.50 %	2.87 %
Investment	3.75 %	4.58 %
Exports	2.50 %	2.35 %
Imports	3.75 %	3.90 %
Aggregate demand	2.50 %	2.82 %
Step	17	(1 to 17)

An increase in money supply (which is the outcome of an open-market purchase on behalf of the Fed) decreased both the nominal short-run interest rate and the nominal long-run interest rate. The real long-run interest rate also declines. Inflation is up. Consumption and investment growth increases. The growth of exports decreases, because of the less favorable exchange rate. Domestic products now are more expensive on the foreign market. The growth of imports increases. Overall, the growth in aggregate demand increases which is the reason why inflation is up. When compared to the base scenario the additional bond purchases have stimulated demand growth.

3.7.   Scenario 6 - Bond Purchase and Reserve Deposit Ratio Change

3.7.1. Intermediate Level

This scenario examines a combination of methods by which one might determine a solution to the Fed's interest rate goal. This scenario will use Excel's Solver to achieve an interest rate goal of 4.5 percent. For this scenario, the user chooses a combination of Bond Purchases and Reserve Deposit Ratio changes to arrive at the solution. Certain restrictions will be placed on the changes.

Figure 53 - Assumptions – Scenario 6

Fractional Reserve Banking					
Basic Assumptions					
Central Bank Assets	$ bill.	Transaction	Central Bank Liabilities	$ bill.	
Discount Loans	$ 2		Currency	$ 457	
Bond Holdings	$ 459	$ 12.0	Bank Reserves	$ 37	
FC Holdings	$ 17	$ -	Liability Other	$ 9	
Gold Holdings	$ 11	$ -	Total Liabilities	$ 503	
Assets Other	$ 25		Central Bank Capital	$ bill.	
Total Assets	$ 514		Total Capital	$ 11	
Banking Variables	%		Total Liabilities and Capital	$ 514	
Res Dep Ratio	10.00		Economy	$ bill.	
Excess Res.	7.50		Market Bond Supply	$ 5,745	
Public Preferences	%		Initial M1	$ 1,081	
Cash Holdings	14.19		Initial Financial Wealth	$ 6,826	
Step	17	(1 to 17)			
When the process runs to completion, we have a new M1 and Money Multiplier that is based on the parameters that are in effect for the assumed changes.					

Bond holdings have been set to 12.00 and the step counter has been set to 17. To gauge the final impact using the solver function within Excel, the step counter must be set to 17.

To the right of the *Basic Assumption Screen* is an entry screen that allows the user to enter upper and lower targets for this model. The *Interest Rate source*, refers to the *Impact of Money on Interest Screen – cell D18 – Current Short Run Interest*. Solver needs a target cell on the active page for solver to work. If the user wishes to make another variable on one of the other sheets a source for solver, this target cell should be changed to reference that cell. The target screen appears as follows:

Figure 54 - Targets – Scenario 6

Fractional Reserve Banking						
Basic Assumptions						
Central Bank Assets	$ bill.	Transaction	Central Bank Liabilities	$ bill.	Target	Source
Discount Loans	$ 2		Currency	$ 457	5.00	Interest Target
Bond Holdings	$ 459	$ 12.0	Bank Reserves	$ 37	$ 14.00	Upper Bonds
FC Holdings	$ 17	$ -	Liability Other	$ 9	$ -	Lower Bonds
Gold Holdings	$ 11	$ -	Total Liabilities	$ 503	$ -	Upper Gold
Assets Other	$ 25		Central Bank Capital	$ bill.	$ -	Lower Gold
Total Assets	$ 514		Total Capital	$ 11	$ -	Upper FC
Banking Variables	%		Total Liabilities and Capital	$ 514	$ -	Lower FC
Res Dep Ratio	10.00		Economy	$ bill.	0.00	Upper Res. Dep.
Excess Res.	7.50		Market Bond Supply	$ 5,745	6.00	Lower Res. Dep
Public Preferences	%		Initial M1	$ 1,081	0.00	Upper Exc. Res.
Cash Holdings	14.19		Initial Financial Wealth	$ 6,826	0.00	Lower Exc. Res.
Step	17	(1 to 17)			0.00	Upper Cash

Once the original entry cells have been reset to the base model, the user should click on the tools menu of Excel and choose "Solver." The Solver Box will appear on the screen as follows:

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Figure 55 - Solver Entry – Scenario 6
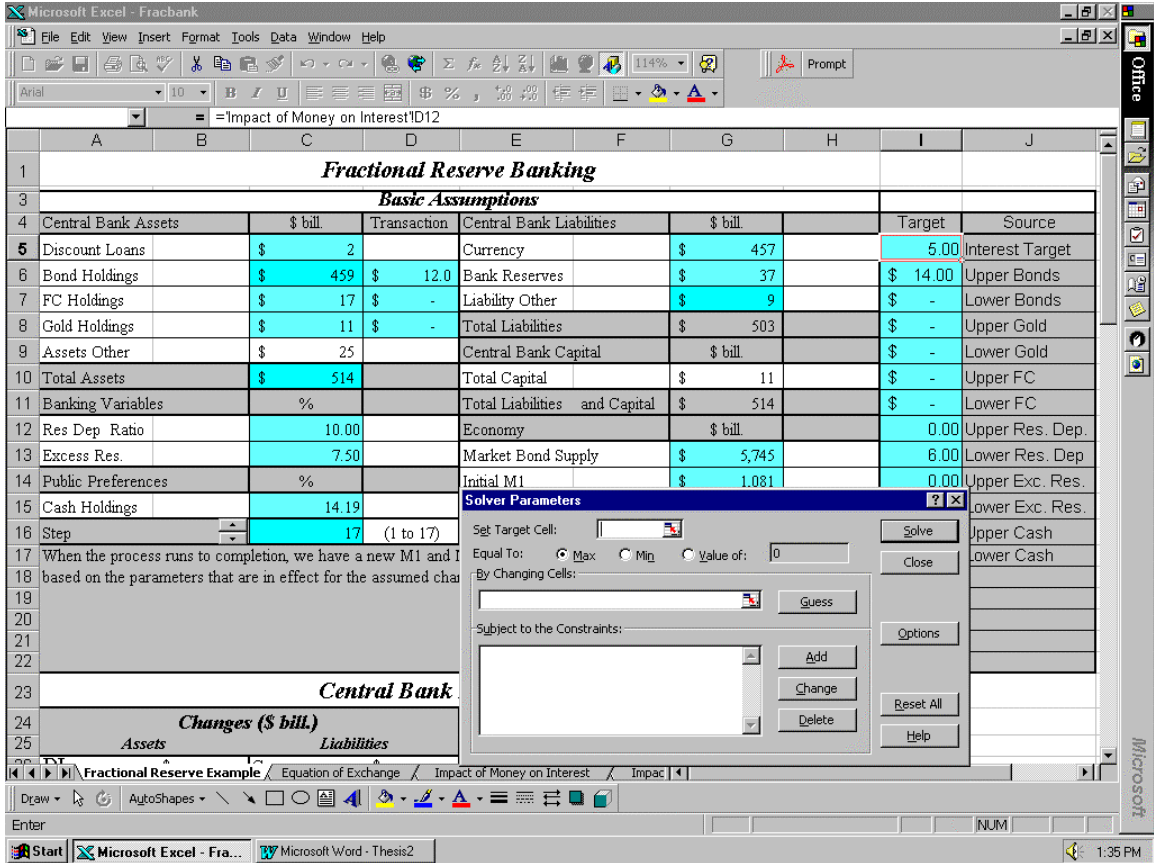
The *Set Target Cell* requires the choice of a cell that the user wishes to equal a certain value. First, the *Set Target Cell* box should be clicked so that it is highlighted. Then the student should click the *Cell - I5* to make this target cell for changes. The cell should say 5.00 percent prior to any calculations. After the enter key is depressed, the screen will jump back to the *Fractional Reserve Example* screen and wait for the next entry.

This scenario will use two constraints in the *By Changing Cell*. Select *Cell – D6 – Bond holdings*, and then enter a comma and select *Cell – C12 – Reserve Deposit Ratio* as the second *By Changing Cell*.

Constraints can now be entered for solver to determine a solution. The columns to the right of the *Basic Assumptions* sheet allow the user to enter upper and lower ranges for each of the variable entries on the *Basic Assumption sheet*. For this example 14.00 has been entered as the *Upper Bond* purchase limit, and 6.00 has been entered as the *Lower Reserve* deposit ratio. To enter these into solver, click on the *Add* button. Once this is done, click on *Cell Reference* and select *cell - D6*. Then set the sign in the middle of the two entries to <= (less than or equal to). Click on the *Constraint Entry* and then select *Cell – I6* (which should have been previously set to 14.00). Once these entries are complete, click on the *OK* button.

Click on the *Add Constraint* button again to add a second constraint for the reserve deposit ratio. Click on *Cell Reference* and select *Cell – C12*. Then set the sign in the middle of the entry section to => (greater than or equal to). Click on the *Constraint Cell* and then select *Cell – I13*, which was previously set to a lower limit of 6.00 percent

Just below the *Set Target Cell* is the option of *Equal to, max, min, or value of*. Select *Equal to* with the mouse and then enter 4.5 (to represent the Fed's goal of 4.5 percent) in the *Value of* section of the screen. The screen should appear as follows:

Figure 56 - Solver Parameters – Scenario 6

Solver is now ready to find the solution. Click the *Solve* button to find the solution.

Figure 57 - Solver Results – Scenario 6
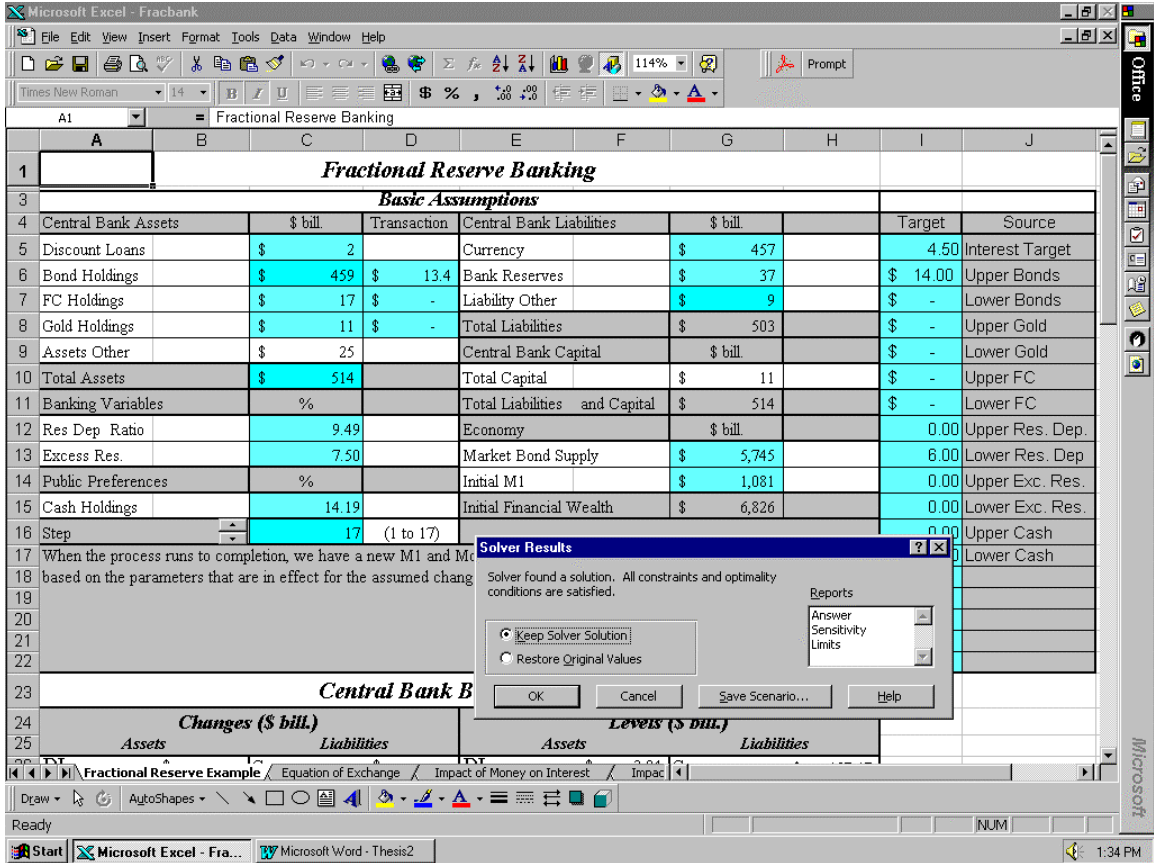
Solver has found a solution based on the constraints given by the user. Click on *OK* to save the solution or click on *Restore Original Values* to discard the changes. Figure 58 shows the results of this last run.

Figure 58 - Assumption Results – Scenario 6

Fractional Reserve Banking					
Basic Assumptions					
Central Bank Assets	$ bill.	Transaction	Central Bank Liabilities	$ bill.	
Discount Loans	$ 2		Currency	$ 457	
Bond Holdings	$ 459	$ 13.4	Bank Reserves	$ 37	
FC Holdings	$ 17	$ -	Liability Other	$ 9	
Gold Holdings	$ 11	$ -	Total Liabilities	$ 503	
Assets Other	$ 25		Central Bank Capital	$ bill.	
Total Assets	$ 514		Total Capital	$ 11	
Banking Variables	%		Total Liabilities and Capital	$ 514	
Res Dep Ratio	9.49		Economy	$ bill.	
Excess Res.	7.50		Market Bond Supply	$ 5,745	
Public Preferences	%		Initial M1	$ 1,081	
Cash Holdings	14.19		Initial Financial Wealth	$ 6,826	
Step	17	(1 to 17)			

Figure 58 now shows that the Reserve Deposit Ratio is 9.49 percent and that bonds were purchased totaling $13.4 billion. The new reserve deposit ratio affects the economy through the money-creation process. Figure 59 indicates the effect on M1 and the Money Multiplier. M1 has increased from $1,080.90 billion to $1,130.01 billion. The money multiplier has increased from 3.6 in the base scenario to 3.66.

Figure 59 - M1 Summary – Scenario 6

<table>
<tr><td colspan="9">Summary of Money Creation Process</td></tr>
<tr><td rowspan="2">Action</td><td colspan="4">Changes in $ bill.</td><td colspan="3">Levels in $ bill.</td><td rowspan="2">Implied Money</td></tr>
<tr><td colspan="2">MB</td><td>M1</td><td>Total Res.</td><td colspan="2">MB</td><td>M1</td></tr>
<tr><td>In old equil.</td><td></td><td></td><td></td><td></td><td>$</td><td>494.43</td><td>$ 1,080.90</td><td></td></tr>
<tr><td>after 1 round</td><td>$</td><td>13.41</td><td>$ 13.41</td><td>$ 13.41</td><td>$</td><td>507.84</td><td>$ 1,094.31</td><td></td></tr>
<tr><td>after 2 rounds</td><td>$</td><td>13.41</td><td>$ 22.97</td><td>$ 11.51</td><td>$</td><td>507.84</td><td>$ 1,103.87</td><td></td></tr>
<tr><td>after 3 rounds</td><td>$</td><td>13.41</td><td>$ 29.77</td><td>$ 10.15</td><td>$</td><td>507.84</td><td>$ 1,110.67</td><td></td></tr>
<tr><td>after 4 rounds</td><td>$</td><td>13.41</td><td>$ 34.62</td><td>$ 9.19</td><td>$</td><td>507.84</td><td>$ 1,115.52</td><td></td></tr>
<tr><td>In new equil.</td><td>$</td><td>13.41</td><td>$ 49.11</td><td></td><td>$</td><td>507.84</td><td>$ 1,130.01</td><td>3.66</td></tr>
<tr><td>Step</td><td colspan="2"></td><td>17</td><td>(1 to 17)</td><td colspan="4"></td></tr>
</table>

The summary table below provides the results of this scenario and compares them to those of the base scenario.

Figure 60 - Summary – Scenario 6

Summary Table with Basic Assumptions and Results		
Assumed Exogenous Growth Rates		
Output		2.50 %
Foreign Output		2.50 %
Levels and Growth Rates	*Base scenario*	*Final*
M1 growth	4.00 %	4.54 %
nominal short run interest rate	5.00 %	4.50 %
nominal long run interest rate	5.00 %	4.99 %
real long run interest rate	2.50 %	1.95 %
inflation (Phillips curve)	2.50 %	2.87 %
expected depreciation	1.50 %	1.00 %
percent change in real e	0.00 %	0.50 %
Resulting percentage changes	*Base scenario*	*Final*
Consumption	2.50 %	2.62 %
Investment	3.75 %	4.03 %
Exports	2.50 %	2.45 %
Imports	3.75 %	3.80 %
Aggregate demand	2.50 %	2.61 %
Step	17	(1 to 17)

The Fed does not directly control cash withheld and excess reserves. These are not options to drive to the solution of a 4.5 percent interest rate; thus, these factors have been excluded from the above solutions.

An increase in the money supply leads to a decrease in the nominal short-run interest rate. The nominal long-run interest rate decreases, as has the real long-run interest rate. Inflation is up. The growth of consumption increases, as does investment growth. The growth of exports decreases because of the less favorable exchange rate. Domestic products are now more expensive on the foreign market. The growth of imports increases due to changes in the exchange rate. Foreign goods have now become comparatively less expensive. Growth in aggregate demand increases.

CHAPTER 4

Educational Pedagogy

4.1.   Relevancy

There is no doubt that the recent events in the U.S. stock market (September / October 1998) have focused attention on the Fed and its reaction to the markets' effect on the economy. Almost daily, there are references to the Chairman of the Federal Reserve making comments about the state of the economy. The media and market gurus try to interpret every statement that the chairman makes to gauge what the Fed might do. Wild market swings can occur in anticipation of any action that the Fed might take. These real-world issues make the application of this model relevant to the classroom. Topics such as inflation, interest rates, exchange rates, and monetary policy are a daily part of an economics student's academic life. The ability of the model to interconnect these topics gives the student the chance to interpret the actions of the Fed and to gauge their effects on the economy.

The narrative in Chapter 2 develops the theoretical model for the student. It takes the theory behind each portion of the model and links the theories together to provide an overall picture of the model's development. This chapter is designed specifically to be incorporated into a lesson plan linking the theory of the model to practical application.

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4.2. Model Use in the Classroom

The model is best presented in an environment where the teacher has access to a computer and projection screen within the classroom. As the model is discussed, the spreadsheet application can be viewed, from within the PDF document, on the projection screen at the front of the room. While this is the most desirable method to present the model, the application can also be explained from a paper copy of this dissertation, and practical application of the model can be made wherever a computer is available. The presentation computer should have direct access to the Internet so that hyperlinks within the PDF document can be used to explore relevant topics across the web.

The teacher should spend enough time using the model to become comfortable with its use and application prior to presenting it to the class. Application of the model will require a basic understanding of spreadsheet applications and the use of other Microsoft products (such as Explorer).

Once the teacher is comfortable with the model, the presentation to the students can either be:

- An overview: The basic functions of the model are examined at a topical level.

- In depth: Each cell calculation is examined to link theory with practical application.

The level of teaching should be determined by the level and aptitude of the class being taught. Each teacher needs to gauge the level and preparedness of the students prior to working through the model.

The model has been divided into two sections:

- Introductory level: This level deals with the money-creation process, the equation of exchange, and interest rates.

- Intermediate level: This level develops the impact of inflation and interest rates on nominal and real exchange rate, consumption, investment, net exports, and aggregate demand.

These suggested divisions could be ignored when a teacher believes students are capable of understanding the concepts. The ability to change and interpret the model is an important part of the model's application.

The teacher is encouraged to use the spreadsheet to give additional assignments to students for out-of-class work. The model can also be used to assign selected presentation topics to students, requiring the student to present a scenario to the class and discuss its application. A suggestion for additional presentations would be to have the students change the source data of the model to that of another country. The students can then model monetary policy based on the new data entered. This option requires both an understanding of the model and the ability to research the data requirements for the new central bank entries.

4.3. Research Tools

The advent of personal computers has revolutionized both the workplace and classroom environment. The applications available to students today enhance the learning process considerably. The ability to search the web for relevant topics, data, or news is crucial to both the learning and the business-development environment. As students enter the working environment, possibly within their chosen major, they are required to exhibit data collection, manipulation, and analytical skills not required of students in the past. It is crucial that skills developed in the classroom be portable. A major factor in the choice of Excel for this model is the need to develop such skills. The use of the web is crucial in developing the research skills needed within the classroom and workplace. Students must develop both, the ability to determine the validity of sources, and search skills that will expand the base of knowledge from which they operate. The model's use of web references is a starting point for the development of these skills.

As a minimum, each student needs to be able to:

- Use Excel to create and modify existing scenarios.

- Use the Web to link to other sites referred to within the document.

- Use a Word Processor to prepare an analysis of a scenario.

- Explore the use of PDF files and document links.

CHAPTER 5

5.1. Summary

The purpose of this dissertation has been to develop a model that can be used in introductory and intermediate macroeconomics classes to convey to students some key aspects of how money is created and how money affects the economy. The dissertation's primary goals are:

- To provide a tool that teaches economic theory in a practical way.

- To familiarize the student with new modeling tools.

The model uses the money creation process to introduce to the student relationships between money, bonds, interest rates, exchange rates, and output. The structure of the model allows the student to link the effects of changes in the money supply to the economy, while helping the student understand the economic costs of certain choices of action. Participation by the student in the problem-solution process helps to reinforce the concepts being covered.

5.1.1. Suggested Model Extensions

While the model addresses the main functions of the money creation process and its relationships with other sectors of the economy, it is by no means comprehensive enough to cover all variations in monetary systems. By design, the model covers in detail each of the steps in the money creation process and the effects of this process on the U.S. economy. Discussion has centered mainly on money creation through open market

policy typical of the United States. While this is the primary means of monetary policy in the United States, other countries use other methods for their monetary systems.

5.1.1.1. Alternative Monetary Arrangements

While not the principal focus of the model, alternate monetary transactions can be entered into the spreadsheet. The model allows both gold and foreign currency transactions as methods of controlling the economy. A suggestion for expanding the model would be to introduce more detail with regard to the methods through which monetary policy is implemented in each of the alternate monetary systems. Attention should be paid to the gold standard, which operated prior to World War 1, and its effects on exchange rates and currencies. The relationship between this fixed exchange rate and its effect on trade could be examined.

The revised model could also deal with how the gold standard and currency board systems force countries to give up control of their monetary policy. Their money supply is determined by gold and currency flows between countries. The revision may address the Bretton Woods system of fixed exchange rates, which replaced the gold standard after 1945, or a currency board system as implemented in Argentina.

5.1.1.2. Three Asset World

The current model is based on a *two-asset* world where bonds (B) and money (M1) comprise total wealth. This is a simplification of financial wealth (W) and the relationship between bonds (B) and money (M1). The model ignores corporate equity (V) as a component of wealth. In a more advanced application of the model, this third

component of wealth could be added, using a more developed portfolio balance approach to model the interest rate.

5.1.1.3. Interest Rate Limitations

One limitation of the model is that large changes occurring in the bond, gold, or foreign currency markets may cause the calculated interest rates to become negative. With the model set at 10 percent required reserves, interest rates become negative when $28.5 billion of bonds are purchased by the Fed. This is caused by the fact that bond demand and money demand functions are linear. Future editions of the model could offer a choice of linear and non-linear demand to ensure that negative numbers do not occur for interest rates.

5.2.   Conclusion

This model contributes to the teaching of the money creation process and its effect on the economy in the following ways:

First, the model provides a tool that utilizes new technology within the classroom. The use of these new tools is an important factor in assisting students to develop critical skills in data manipulation and data management.

Second, the model helps the teacher assimilate new methods of teaching into the classroom. The use of new modeling tools in the teaching environment enhances the effectiveness of both the teaching and learning experience.

Third, the model helps students to comprehend difficult relationships within the economy and improves their understanding of these concepts.

Fourth, the model reduces learning time by allowing students to work "at their own pace".

While every effort has been made to ensure that the model is both functional and informative, the teaching and learning responsibilities remain with the user. The teacher needs to use and understand the model prior to presenting it in the classroom. However, the students are responsible for reading and understand basic concepts and modeling methods presented in this document.

The basic approach of the model is to address the money-creation process and its effect on the economy. The design, while at times simple, allows the user to view the intended processes and gain a better understanding of the money and banking system as a whole. Its application at the introductory and intermediate level of economics provides a new learning tool that, when used effectively, better prepares the student for work within the major.

Appendix A

Table 14 - Internet References

TOPIC	INTERNET SITES
Money and Banking	http://patriot.net/~bernkopf/ http://www.bog.frb.fed.us/ http://dir.yahoo.com/Business_and_Economy/Finance_and_Investment/Banking/Central_Banks/ http://www.csufresno.edu/Economics/econ_EDL.htm
Resources for Economists on the Internet	Http://econwpa.wustl.edu/EconFAQ/EconFAQ.html Http://netec.wustl.edu/WebEc.html Http://www.clark.net/pub/lschank/web/business.html http://www.ssrn.com/ http://www.yardeni.com/ http://www.census.gov/ http://www.clark.net/pub/lschank/web/ecostats.html http://www.access.gpo.gov/su_docs/budget/index.html http://www.mtsu.edu/%7Edgraddy/future/findata.htm
Journals and Articles	http://www.elsevier.com/homepage/sae/econbase/menu.sht http://www.frbsf.org/system/fedinprint/index.html http://www.bog.frb.fed.us/pubs/workingpapers.htm http://www.bog.frb.fed.us/otherfrb.htm
Fair Model of the U.S.	http://fairmodel.econ.yale.edu/
Economic Indicators	http://www.globalexposure.com/index.html http://stats.bls.gov/datahome.htm http://dir.yahoo.com/Business_and_Economy/Economic_Indicators/ http://www.mtsu.edu/%7Edgraddy/future/ecdata.htm

Table 14 - Internet References cont…

Policy	http://dir.yahoo.com/Social_Science/Economics/Economic_Policies_and_Regulations/
Education	http://dir.yahoo.com/Social_Science/Economics/Education/

Source: World Wide Web search engines: Yahoo.com and Altavista.com

Appendix B

Table 15 - File Documentation

FILE NAME AND TYPE	DESCRIPTION
Map.PDF	PDF - Data Diagram of the model flow
Fracbank.xls	Excel Spreadsheet Model
Dissertation.PDF	PDF – Copy of Dissertation with embedded hyperlinks.

Appendix C

Table 16 - Federal Reserve Bulletin

Assets

SPREADSHEET TITLE	DESCRIPTION	$ BILL.
Discount Loans	Loans to Depository Ins.	2.035
Bond Holdings	US government and federal agency securities, net	458.555
FC Holdings	Investments denominated in foreign currencies	17.046
Gold Holdings	Gold certificates	11.047
Assets Other	Sum of Special drawing rights certificates, Coin, Items in process of collection, Accrued interest receivable, Bank premises and equipment net, Other assets	25.239
Total Assets	Total Assets	513.922

Liabilities

SPREADSHEET TITLE	DESCRIPTION	$ BILL.
Currency	Federal Reserve notes outstanding, net	457.469
Bank Reserves	Sum of Depository institutions, U.S. Treasury general account, Other deposits	36.963
Liability Other	Sum of Deferred credit items, Statutory surplus transfer due U.S. Treasury, Accrued benefit cost, Other liabilities	8.84

Capital

SPREADSHEET TITLE	DESCRIPTION	$ BILL.
Central Bank Capital	Sum of Capital paid-in, Surplus	10.653

Table 16 - Federal Reserve Bulletin Cont…

Liabilities and Capital

SPREADSHEET TITLE	DESCRIPTION	$ BILL.
Total Capital and Liabilities	Sum of Total Liabilities, Total Capital	513.922

Source: <u>Federal Reserve Bulletin</u>, Board of Governors of the Federal Reserve System, Washington D.C., Vol. 84, No. 7 (July 1998).

Appendix D

Table 17 - Economic Indicators June 1998

SPREADSHEET TITLE	ECONOMIC INDICATORS DESCRIPTION	$ BILL.
Market Bond Supply	M3 Plus other liquid assets – April estimate	6,825.6
Initial M1	M1 Sum of currency, demand deposits, travelers checks, and other checkable deposits (OCDs)	1,078.1

Source: Economic Indicators, (June 1998), Prepared for the Joint Economic Committee by the Council of Economic Advisors (data available as of July 7, 1998).

Appendix E

Table 18 - Real Gross Domestic Product (Billions of Chained 1992 Dollars)

YEAR	GDP	GROWTH
1959	2230.95	
1960	2238.57	0.34%
1961	2381.01	6.36%
1962	2476.67	4.02%
1963	2604.62	5.17%
1964	2739.75	5.19%
1965	2970.48	8.42%
1966	3102.36	4.44%
1967	3177.98	2.44%
1968	3331.22	4.82%
1969	3392.61	1.84%
1970	3389.36	-0.10%
1971	3533.79	4.26%
1972	3790.44	7.26%
1973	3947.11	4.13%
1974	3854.13	-2.36%
1975	3952.48	2.55%
1976	4126.39	4.40%
1977	4328.34	4.89%
1978	4603.65	6.36%
1979	4656.23	1.14%
1980	4651.86	-0.09%
1981	4693.76	0.90%
1982	4618.26	-1.61%
1983	4939.23	6.95%
1984	5203.68	5.35%
1985	5393.57	3.65%
1986	5526.77	2.47%
1987	5750.57	4.05%
1988	5952.83	3.52%
1989	6093.51	2.36%
1990	6078.96	-0.24%
1991	6105.25	0.43%
1992	6327.12	3.63%
1993	6476.86	2.37%
1994	6688.61	3.27%

Table 18 - Real Gross Domestic Product (Billions of Chained 1992 Dollars) Cont…

1995	6825.8	2.05%
1996	7093.12	3.92%
1997	7364.63	3.83%
Average		3.22%

Source: SAAR//gdpc92

http://bos.business.uab.edu/charts/

Appendix F

Table 19 - CPI - (All Urban Consumers)

YEAR	MONTH	DATA	CHANGE
1947	12	23.4	
1948	12	24.1	2.99%
1949	12	23.6	-2.07%
1950	12	25	5.93%
1951	12	26.5	6.00%
1952	12	26.7	0.75%
1953	12	26.9	0.75%
1954	12	26.8	-0.37%
1955	12	26.9	0.37%
1956	12	27.6	2.60%
1957	12	28.5	3.26%
1958	12	29	1.75%
1959	12	29.4	1.38%
1960	12	29.8	1.36%
1961	12	30	0.67%
1962	12	30.4	1.33%
1963	12	30.9	1.64%
1964	12	31.3	1.29%
1965	12	31.9	1.92%
1966	12	32.9	3.13%
1967	12	34	3.34%
1968	12	35.6	4.71%
1969	12	37.7	5.90%
1970	12	39.8	5.57%
1971	12	41.1	3.27%
1972	12	42.5	3.41%
1973	12	46.3	8.94%
1974	12	51.9	12.10%
1975	12	55.6	7.13%
1976	12	58.4	5.04%
1977	12	62.3	6.68%
1978	12	67.9	8.99%
1979	12	76.9	13.25%
1980	12	86.4	12.35%
1981	12	94.1	8.91%
1982	12	97.7	3.83%
1983	12	101.4	3.79%
1984	12	105.5	4.04%
1985	12	109.5	3.79%
1986	12	110.8	1.19%
1987	12	115.7	4.42%

Table 19 - CPI - (All Urban Consumers) cont…

1988	12	120.8	4.41%
1989	12	126.4	4.64%
1990	12	134.3	6.25%
1991	12	138.3	2.98%
1992	12	142.4	2.96%
1993	12	146.4	2.81%
1994	12	150.2	2.60%
1995	12	154.1	2.60%
1996	12	159.2	3.31%
1997	12	161.9	1.70%
Average			3.99%

Source: Consumer Price Index: Total; All Urban Consumers SA//cpiaucsl

Http://bos.business.uab.edu/charts/

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EQUATIONS

130

Central Bank
- Reserve Requirements
- Open Market Transactions

Banking System
- Voluntary Excess Reserves

Public
-Cash Held

MB = Monetary Base

M1 = Money Supply

Equation of Exchange

M1 x V = P x Y

Convert to Percent Change Form

$\hat{M1} \times \hat{V} = \hat{P} \times \hat{Y}$

Assumed $\hat{Y}$

$\hat{V}$

Portfolio Balance Approach (2 Asset World)

Wealth = M1 + Bonds

Expected Inflation

Short run nominal interest rate: i

$\hat{Consumption (C)}$

Expected short run interest rate:
$i_{exp} = i + $ (expected inflation - actual inflation)

Long run interest rate (expectations theory)
$i_l = (((1 + i) (1+i_{exp})^{n-1})^{1/n})-1$

Government $\hat{Spending}$ (G)

Real long run interest rate:
$r_l = i_l - $ expected inflation

$\hat{Investment (I)}$

Foreign Influence

Uncovered Interest Rate Parity (UIP)
$i = i_{foreign} + \hat{e}$ (expected depreciation)

Foreign Income Growth

Real Exchange Rate
$\hat{e}_{real} = -\hat{e} - $ foreign inflation $+ \hat{p}$

$\hat{Exports (X)}$

$\hat{Imports (M)}$