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Structural change in the demand for money following the Treasury-Federal Reserve Accord of 1951: An application of the loanable funds model

Ho, Sophia Sheung Ying, Ph.D.

University of Hawaii, 1993

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STRUCTURAL CHANGE IN THE DEMAND FOR MONEY
FOLLOWING THE TREASURY-FEDERAL RESERVE ACCORD OF 1951:
AN APPLICATION OF THE LOANABLE FUNDS MODEL

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF HAWAII IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY
IN ECONOMICS
MAY 1993

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Alvin Y.C. So
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ABSTRACT

In adopting an interest-pegging policy to finance the Second World War, the Federal Reserve had essentially surrendered its ability to control the money supply. Monetary policy was implicitly abandoned. During the pegging period, monetary growth had to be whatever was required to keep interest rates at their pegged level. If some exogenous shock tended to increase interest rate, the Fed would have to purchase government securities and thus caused the money supply to increase. As interest rates tended to fall, the Fed would have to sell government securities to absorb excess liquidity at the pegged rates and therefore money supply would fall.

The Treasury-Federal Reserve Accord of 1951 provides a unique opportunity to explore the impact of a change in a monetary regime. The shift in the monetary regime - away from pegging the interest rate - was a well-publicized event. People were aware of the implications and adjusted their economic behavior accordingly. Inflationary expectations were lowered and so was the substitutability of government securities for money balances due to the Accord. Higher interest rate volatility means higher risk in terms of capital losses on the part of holders' of government securities as the price of government securities varies inversely with the interest rate. Government securities
were no longer a close substitute for money balances as they were during the price-pegging era.

The revival of an independent monetary policy was possible only after the Accord. Instead of being an "engine of inflation," the Fed returned to the "driver's seat" for the first time since 1942. By abandoning the pegging of long-term rates, the Fed regained its ability to control the money supply. Ironically, the Fed did not tighten up the money supply despite enormous inflation generated by the Korean War. Money supply increased at an even faster rate, and yet wholesale prices started to fall. This was one of the few episodes in American financial history that the economy experienced decreasing inflation along with an acceleration in the rate of monetary growth. This observation contradicts most macro-economic theories which maintain a positive relationship between monetary growth and change in the price level. The apparent paradox can be explained by an increase in demand for money after the Accord applying the loanable funds model.

The thesis of the study is to 1) demonstrate the ability of the loanable funds model to explain the monetary actions during the price-pegging period and 2) examine the structural change in the demand for money as a result of the shift in the monetary regime recognizing the endogeneity of the money supply.
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<td>MONEY SUPPLY (M1 &amp; M2), WHOLESALE PRICES (WSP), AND THEIR ANNUAL GROWTH RATES - SELECTED MONTHS FROM THE YEAR BEFORE TO THE YEAR AFTER THE ACCORD</td>
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1.1 EVENTS LEADING TO THE TREASURY–FEDERAL RESERVE ACCORD

1.1.1 The Finance of WWII and Postwar Inflation 1942–48

The United States formally entered World War II after the Pearl Harbor attack by the Japanese on December 7, 1941. Despite its nature as an independent agency responsible to Congress to regulate money and credit in order to maintain economic stability, the Federal Reserve System assumed the subordinate role of helping the Treasury sell government securities to finance the war effort. The Board of Governors committed itself to do everything in its power to provide sufficient reserves to facilitate Treasury financing: "The System is prepared to use its powers to assure that an ample supply of funds is available at all times for financing the war effort and to exert its influence toward maintaining conditions in the U.S. government security market that are satisfactory from the standpoint of the Government requirements."¹

In the Annual Report of 1942, the Board of Governors further extended the System's commitment to maintain a fixed pattern of rates on government securities at approximately the level which prevailed at the beginning of the war.

Although the Fed originally favored a long-term financing program which would peg the yield on long-term bond at 2-1/2 percent while allowing the yields on short-term securities to reflect changing market conditions, the Treasury maintained that the yields on short-term securities had to be pegged at 1/4 percent in order to stabilize the 2-1/2 percent rate for the long-term bonds. Despite the fact that Fed officials regarded the 1/4 percent rate on short-term securities as abnormally low and potentially inflationary, they conceded to the Treasury's position. In March of 1942, the Fed officials agreed to peg 30 day Treasury Bills at a slightly higher rate of 3/8 percent and maintained at this rate until the middle of 1947. Although there was no formal commitment on the part of the Fed to peg the prices of government securities of longer term, the Fed effectively pegged the rate on 9-12 months certificate of indebtedness at 7/8 percent and long-term government securities at 2-1/2 percent. Open market operations were used to maintain this fixed pattern of rates.

The justification for pegging interest rates during the war period was to keep interest costs down for war financing. It was also done to guard against capital losses on government securities as occurred during World War I when interest rates increased from 3-1/2 percent on the first Liberty Bond issue in 1917 to 4-1/4 percent in 1918, and finally to 4-3/4 percent on the Victory loan issue in 1919.
Investors who purchased earlier bond issues suffered significant capital losses. By pegging a fixed pattern of rates or committing itself to buy and sell any amount of government securities at their par values, the Fed essentially eliminated the risk to bondholders of suffering any capital losses due to increases in interest rates in the future.

In adopting the price-pegging policy, the Federal Reserve had essentially surrendered its ability to control the money supply. Monetary policy was implicitly abandoned. During the pegging period, monetary growth had to be whatever was required to keep interest rates at their pegged level. If some exogenous shock tended to increase interest rates, the Fed would have to purchase government securities and thus caused the money supply to increase. As interest rates tended to fall, the Fed would have to sell government securities to absorb excess liquidity at the pegged rates and therefore money supply would fall.

The other problem associated with this policy was known as "playing the pattern of rates." Knowing that the yield and the price of securities are inversely related and that the Fed was committed to buy 3-month Treasury securities at the pegged rate of 3/8 percent, investors could enjoy a capital gain by selling the longer term securities three months before maturity rather than holding them to maturity. This fixed pattern of rates encouraged investors to buy
longer-term securities and get rid of the short-term securities in order to increase their returns. This practice was so widespread during the period that virtually all 3-month Treasury securities ended up with the Fed.

The other consequence of this bond-pegging policy was the creation of enormous inflationary pressures although these pressures were suppressed by price controls and rationing during the war. The M1 Money supply increased at an annual rate of 20 percent and M2 of 19 percent from November 1941 to January 1946. However, as a result of price controls, wholesale prices increased only by 5.7 percent annually over the same period, as shown in Table 1.1.

<table>
<thead>
<tr>
<th>Month/Year</th>
<th>M1 ($b)</th>
<th>Annual Growth (%)</th>
<th>M2 ($b)</th>
<th>Annual Growth (%)</th>
<th>WSP (1947-49=100)</th>
<th>Annual Growth (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/1941</td>
<td>47.9</td>
<td>20.0</td>
<td>63.9</td>
<td>19.0</td>
<td>59.3</td>
<td>5.7</td>
</tr>
<tr>
<td>1/1946</td>
<td>101.9</td>
<td>3.4</td>
<td>132.5</td>
<td>4.0</td>
<td>74.8</td>
<td>14.8</td>
</tr>
<tr>
<td>8/1948</td>
<td>111.5</td>
<td>147.1</td>
<td>108.2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

During the war years, rationing and price control had essentially eroded the value of money and the function of prices. Distribution of final goods and services did not
depend on the ability of consumers to pay for those goods and services but rather on the availability of ration coupons. There had been forced saving and an accumulation of money balances throughout the war years because of shortages of consumer goods, particularly consumer durable goods. When World War II was finally over in September 1945, rationing was abandoned. As consumer durable goods became available again after the war, people began to draw on their excess money balances accumulated during the war years to satisfy the backlog demand. Price controls were modified in June 1946 and eliminated completely in November 1946 and prices soared.

On July 10, 1947, the Federal Reserve under its chairman, Marriner S. Eccles, successfully made the first change in the pattern of rates on government securities when the Treasury bill rate was allowed to rise above its posted level of 3/8 percent. This was done to prevent runaway inflation due to the Fed's commitment to peg a fixed pattern of rates. The Treasury agreed with this move apparently because the Federal Reserve System, on April 23, 1947, adopted a policy of paying about 90 percent of the net earnings of the Federal Reserve Banks to the Treasury to provide the Treasury for the increased interest costs. The rate on a certificate of indebtedness was also raised from

---

7/8 percent to 1-1/8 percent soon after this compromise in December and newly issued certificates reached 1-1/4 percent a year later. However, it should be noted that these minor rate changes were adjustments in and not a repudiation of the policy of a fixing a pattern of interest rates as the pegging of the long term 2-1/2 percent rate was still in effect.

From January 1946 to August 1948, as shown in Table 1.1, wholesale prices went up at an annual rate of 14.8 percent. The M1 money supply increased by 3.4 percent and M2 by 4.0 percent annually for the same period. From the first quarter of 1946 to third quarter of 1948, the income velocity of money M1 increased from 1.8 to 2.2 and M2 from 1.4 to 1.7, as shown in Table 1.2.

TABLE 1.2 INCOME VELOCITY OF MONEY M1 AND M2 (V1 & V2) AND THEIR ANNUAL GROWTH RATES (g1 & g2) - SELECTED QUARTERS FROM THE END OF PRICE CONTROLS TO THE YEAR AFTER THE ACCORD

<table>
<thead>
<tr>
<th>Year/Quarter</th>
<th>NNP ($b)</th>
<th>M1 ($b)</th>
<th>M2 ($b)</th>
<th>V1</th>
<th>g1 (%)</th>
<th>V2</th>
<th>g2 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1946/I</td>
<td>186.9</td>
<td>102.1</td>
<td>133.6</td>
<td>1.82</td>
<td>+7.9</td>
<td>1.40</td>
<td>+7.3</td>
</tr>
<tr>
<td>1948/III</td>
<td>245.6</td>
<td>111.4</td>
<td>147.0</td>
<td>2.20</td>
<td>+1.8</td>
<td>1.67</td>
<td>+1.7</td>
</tr>
<tr>
<td>1950/II</td>
<td>255.9</td>
<td>112.5</td>
<td>149.0</td>
<td>2.27</td>
<td>+14.1</td>
<td>1.72</td>
<td>+15.1</td>
</tr>
<tr>
<td>1951/II</td>
<td>304.0</td>
<td>117.2</td>
<td>153.5</td>
<td>2.59</td>
<td>-1.2</td>
<td>1.98</td>
<td>-1.5</td>
</tr>
<tr>
<td>1952/II</td>
<td>316.6</td>
<td>123.8</td>
<td>162.5</td>
<td>2.56</td>
<td></td>
<td>1.95</td>
<td></td>
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</tbody>
</table>
The immediate postwar inflation might have been more severe had the rise in the income velocity of money not been so small. If the income velocity of money returned to its prewar level, prices would have had to rise by an annual rate of 20 percent. If the public had wished to exchange more of their money balances for goods and services, income velocity of money would have risen more. The reason the public did not spend more or they were willing to reduce their money balances so gradually was the expectation of a major postwar slump accompanied by falling prices. Although inflation was indeed rife from mid-1946 to mid-1948, it was widely viewed as a once-and-for-all adjustment to the suppressed inflation caused by wartime controls. People did not expect inflation to continue indefinitely. In fact many, remembering the sharp price decline after World War I, considered the post war inflation to be nothing but a ride up a roller coaster which would soon come hurtling down. This opinion was further strengthened by much-publicized predictions of many "experts" that war's end would be followed by a major economic collapse. If one thinks that prices will soon be plunging and jobs will be hard to get, there is good reason to hang on to money balances and other

---

3 The income velocity of money supply M1 and M2 were 2.52 and 1.87 respectively for the year of 1941.

liquid assets. Inflation during 1946-1948 caused concern, but deflation was expected to follow, and this expectation moderated the inflation.\(^5\)

1.1.2 The Mild Recession 1948-49

As the economy began to divert resources to the production of consumer goods, the backlog demand of for durable goods was gradually satisfied. Moreover, a decline in net exports and government spending began to hurt the economy by the second half of 1947. The economy slowed down due to 1) a fall in consumer spending due to the satisfaction of backlog demand for consumer durable in 1947, 2) drastic decline in exports caused by actions taken by European countries to contain the gold drain and 3) substantial government cash surpluses of $5.7 billion and $8.0 billion in calendar years 1947 and 1948 due to a decrease in government spending after the war. Now the commitment of the Federal Reserve to peg bond prices at par values required the Federal Reserve to sell government securities. During the first half of 1948, the Federal Reserve sold over $3 billion of bonds in open market operations. Fearing that the bond pegging commitment would lead to a cumulative process of deflation, the Federal Reserve finally announced that it would allow the prices of government securities to rise above par values on June 29,

1948. Nevertheless, the money supply M1 fell (from $112.6 billion to $110.2 billion) 2.1 percent for the year 1948, and the economy went into a recession in November 1948. Net nominal national product decreased by 4.1 percent from the fourth quarter of 1948 ($246.4 billion) to the fourth quarter of 1949 ($236.4 billion), and wholesale prices decreased by an annual rate of 7.4 percent from August 1948 (108.2) to December 1949 (97.7).

The economy began to recover by early 1950 mainly because of a Republican tax cut of $4.7 billion in February 1948 and the Marshall Plan (the European Recovery Program) which was signed into law on April, 1948. The money supply M1 increased (from $109.9 billion to $112.5 billion) at an annual rate of 4.8 percent while M2 (from $146 billion to $149 billion) at an annual rate of 4.2 percent from the last quarter of 1949 to the second quarter of 1950.

1.1.3 The Korean War Inflation 1950-51

The outbreak of the Korean War on June 24, 1950 caused the public to go on a buying spree with the anticipation of inflation, or rationing and price control with the attendant shortages of consumer goods. The buying spree caused the income velocity of money to rise sharply as inflationary expectations made the holding of money balances less attractive. Inflationary expectations also lowered the expected real return on government securities and thus also made them less attractive compared to goods and services.
In order to prevent bond prices from falling below par value and interest rates from rising, the Federal Reserve had to purchase government securities in open market operations. Money supply increased at a faster rate, as did wholesale prices. Four months later, with the fall of Pyongyang on October 19, 1950, retail sales broke sharply downward as people expected the war would soon be over. However, the Chinese entered the conflict in December 1950. When Seoul fell to the Communist forces again, another wave of consumer purchases began back home. The income velocity of the money supply M1 shot up 14 percent from second quarter of 1950 to second quarter of 1951, while of M2 increased 15 percent, as shown in Table 1.2. Wholesale prices increased by 18.3 percent for the year from March 1950 to March 1951, as shown in Table 1.3.

TABLE 1.3 MONEY SUPPLY (M1 & M2), WHOLESALE PRICES (WSP), AND THEIR ANNUAL GROWTH RATES - SELECTED MONTHS FROM THE YEAR BEFORE TO THE YEAR AFTER THE ACCORD

<table>
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<th>Month/Year</th>
<th>M1 ($b)</th>
<th>Annual Growth (%)</th>
<th>M2 ($b)</th>
<th>Annual Growth (%)</th>
<th>WSP (1947-49=100)</th>
<th>Annual Growth (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/1950</td>
<td>111.4</td>
<td>4.8</td>
<td>147.8</td>
<td>3.4</td>
<td>98.5</td>
<td>18.3</td>
</tr>
<tr>
<td>3/1951</td>
<td>116.7</td>
<td>5.6</td>
<td>152.8</td>
<td>5.7</td>
<td>116.5</td>
<td>-3.6</td>
</tr>
<tr>
<td>3/1952</td>
<td>123.2</td>
<td></td>
<td>161.5</td>
<td></td>
<td>112.3</td>
<td></td>
</tr>
</tbody>
</table>

The Federal Reserve felt that it had to abandon the pegging of government security yields in order to prevent
runaway inflation. However, the Treasury insisted that the Federal Reserve continue to hold down interest rates on long-term bonds at their pegged levels. Marriner Eccles who had been the chairman of the Federal Reserve Board since 1934, was not reappointed on February 1, 1948. Thomas McCabe was appointed chairman two and a half months later on April 15, 1948. Eccles, however, continued to serve out his remaining term as a governor of the Board. The outbreak of the Korean War intensified the conflict between the Treasury and the Federal Reserve.

1.1.4 The Treasury-Federal Reserve Accord 1951

The conflict between the Treasury and the Federal Reserve finally became public in 1951. In a speech to the New York Board of Trade on January 18, 1951, John Snyder, the Secretary of Treasury, stated: "In the firm belief after long consideration, that the 2-1/2 percent long-term rate is fair and equitable to the investor and that market stability is essential, the Treasury Department has concluded, after joint conference with President Truman and Chairman McCabe of the Federal Reserve Board, that the refunding of new money issues will be financed within the pattern of that rate." The Federal Reserve immediately denied any such agreement.

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President Truman then summoned the Federal Reserve Open Market Committee to the White House on January 31. This was the first time in history of the Federal Reserve System that a President called either the Federal Reserve Board or the Federal Open Market Committee (FOMC) to the White House for the purpose of discussing or influencing their policies. After the meeting, the President announced that the Federal Reserve agreed to maintain the yields on government securities at existing levels. Eccles denied the agreement and released the minutes of the Federal Reserve Board to the press on February 4. On February 6, Chairman McCabe called for the FOMC meeting instead of the scheduled meeting on February 13. At the suggestion of Allan Sproul, the chairman of the Federal Reserve Bank of New York, the committee agreed to send letters to the President and to the Secretary of Treasury explaining the grounds for the committee’s resistance to the Treasury’s policy of "pegged prices." This reopened the door for further discussion of debt-management policies between the Treasury and the Federal Reserve.7

The Treasury and the Federal Reserve finally issued a joint announcement on March 4, 1951. The Treasury-Federal Reserve Accord read: "The Treasury and the Federal Reserve have reached a full accord with respect to debt management

and monetary policies to be pursued in furthering their common purpose to assure the successful financing of the government’s requirements and, at the same time, to minimize the monetization of the public debt." It was an apparent victory for the Treasury because it stated that the Federal Reserve would support the bond market, but the crucial element in the agreement was that such support would be limited to 500 million dollars. Three days later, the Federal Reserve had spent all of the agreed upon amount. When Snyder asked for continued support, the Federal Reserve refused. The Treasury then issued new bonds bearing 2-3/4 percent in exchange for all outstanding long-term bonds bearing 2-1/2 percent. This was done to prevent massive capital losses on the existing bonds which were mostly held by the financial institutions. The buying binge and price inflation associated with the start of the Korean War subsided after the declaration of the Accord. As shown in Table 1.3, wholesale prices decreased 3.6 percent from March 1951 to March 1952 as anticipated shortages did not appear. Perhaps more likely, inflationary expectations were diminished by the well-publicized behavior of the Federal Reserve System as related to the Accord.

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9 Hyman, Sidney, Marriner Eccles: Private Entrepreneur and Public Servant, Graduate School of Business, Stanford University, 1976, p. 351.
1.2 SIGNIFICANCE OF THE TREASURY-FEDERAL RESERVE ACCORD

By abandoning the pegging of long-term rates, the Fed could now control the money supply. Instead of being an "engine of inflation," the Fed returned to the "driver’s seat" for the first time since 1942. The revival of an independent monetary policy was possible only after the Accord. Ironically, the Fed did not tighten up the money supply after regaining its ability to control the money supply. Money supply M1 and M2 increased 4.8 percent and 3.4 percent respectively for the year before the Accord. For the year after the Accord, money supply M1 and M2 both increased at a faster pace 5.6 percent and 5.7 percent respectively, as shown in Table 1.3.

This was one of the few episodes in American financial history that the economy experienced decreasing inflation along with an acceleration in the rate of monetary growth. While wholesale prices increased by 18.3 percent for the year before the Accord from March 1950 to March 1951, it decreased by 3.6 percent for the year following the Accord from March 1951 to March 1952, as shown in Table 1.3. While wholesale prices did fall after the Accord, it was not due to a tight money policy adopted by the Fed, at least as

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measured by the growth of the monetary aggregates. Instead the money supply went up at a faster rate after the Accord. Despite the accelerated monetary expansion after the Accord, wholesale prices started to fall. This observation contradicts most macro-economic theories which maintain a positive relationship between monetary growth and change in the price level.

This apparent paradox can be explained by looking at the change in the income velocity of money before and after the Accord. As shown in Table 1.2, the income velocity of M1 and M2 increased by 14.1 percent and 15.1 percent respectively for the year before the Accord from second quarter of 1950 to second quarter of 1951. The same statistics indicate a decline of 1.2 percent and 1.5 percent for the year following the Accord from the second quarter of 1951 to the second quarter of 1952.

Income velocity of money is the inverse of the Cambridge k which is the proportion of national income that people hold in the form of money in the Cambridge equation:

\[ M^d = k y P \]

where \( M^d \) is the money demand;
\( y \) is the real national income;
\( P \) is the price level; and
\( yP \) is the nominal national income.

The faster people try to get rid of their money balances, the lower the Cambridge k and the higher the
income velocity of money. The rapid increase in income velocity of money that began with the outbreak of the Korean War can be explained by the anticipated decreasing future value of money. First of all, there was widespread anticipation of shortages and possible rationing in consumer goods as happened during the Second World War. As the value of money is measured by its ability to acquire goods and services, shortages and/or rationing erodes the value of money. Secondly, the inflationary pressure generated by the price-pegging policy also exerted a negative effect on the future value of money. With anticipation of shortages and possible rationing together with higher inflationary expectation, people responded by converting their money balances into goods and services. Thirdly, while the yield on long-term securities was pegged at 2-1/2 percent at the time, government securities were essentially an interest bearing asset of relatively little risk. The price pegging policy protects the investors from incurring capital losses. Therefore, government securities were an attractive alternative to money balances given that the risk of incurring capital loss was essentially eliminated by the price-pegging policy.

Then came the Accord which drastically altered the expectations of the general public and caused the income velocity of money to drop. First of all, the revival of an independent monetary policy implied that the Fed had
regained its control over the money supply and thus its ability to restore price stability. Inflation would no longer be a self-fulfilling prophecy. It is rational to expect the public to reduce their inflationary expectations after the abandonment of pegging the long-term interest rates. Accordingly, the expected future value of money increased, or at least stopped falling. Secondly, the abandoning of the price-pegging policy made it very clear that the pattern of interest rates would once again be guided by the market forces. More importantly, interest rates were allowed to fluctuate due to changes in the economic conditions. Higher interest rate volatility means higher risk on the part of holders’ government securities as the price of government securities varies inversely with the interest rate. Government securities were no longer a close substitute for money balances as they were during the price-pegging era.

The inflationary pressure prior to the Accord reflected the fact that interest rates had been kept too low. As a result of the Accord, interest rates were allowed to alter in response to changes in market conditions and the rates went up as soon as the Accord took effect. This might have made bond-holding a better hedge against inflation if the risk of incurring capital loss had remained close to zero. Unfortunately, this was not the case. The holders of government securities now faced considerable risk of capital
losses as interest rates were allowed to fluctuate. If risk remains constant, the higher the coupon yield, the more attractive it is to hold bonds rather than money balances. Given the same coupon yield, the higher the risk measured by interest rate volatility the less attractive will be bond-holding. The decrease in income velocity of money implied an increase in demand for money after the Accord. We can conclude that the negative effect of higher interest rate volatility outweighed the positive effect of higher interest rate on demand for bonds. As people now perceived government securities less attractive relative to money balances, they chose to hold more money balances and less in bonds.

The Treasury-Federal Reserve Accord provides a unique opportunity to explore the impact of a change in a monetary regime. The shift in the monetary regime - away from pegging the interest rate - was a well-publicized event. People were aware of the implications and adjusted their economic behavior accordingly. The demand for money balances increased after the Accord as indicated by the change in the income velocity of money. This structural change in money demand explains the paradox of an accelerated monetary expansion along with decreasing inflation. Inflationary expectations were reduced and so was the substitutability of government securities for money balances due to the Accord.
This study examines the factors contributing to the structural change in demand for money due to the shift in the monetary regime. In Chapter Two, we will discuss the loanable funds model with reference to Wicksell's cumulative process and analyze the economic swings during the period which led to the Accord. We will also review theoretical models of demand for money to incorporate in the loanable funds model. In Chapter Three, we will specify a model for empirical analysis. In Chapter Four, we will discuss the data and the results. In Chapter Five, we will conclude the study with the implications of the shift in the monetary regime on the structural change in demand for money.
CHAPTER 2
LITERATURE REVIEW

2.1 LOANABLE FUNDS THEORY

Wicksell postulated that a policy of pegging interest rates would inevitably lead to cumulative inflation or deflation. Any divergence of the market rate of interest from the natural rate of interest would force the monetary authority to create excess supply or demand for money.

2.1.1 Natural Rate and Market Rate of Interest

Natural rate of interest was defined by Wicksell\(^1\) as the rate of interest at which the demand for loan capital and the supply of savings exactly agree, and which more or less corresponds to the expected yield on the newly created capital.\(^2\) Saving occurs when people defer part of their income from current consumption to future use. The use of resources, land and labor etc., which would otherwise have been required in production to satisfy current consumption is available to entrepreneurs to produce capital goods, making future production and consumption possible. If for any reason entrepreneurs pursue more promising prospects for the employment of capital, demand for loan capital will increase and will exceed supply at the current rate of

\(^1\) He referred to it as the normal or natural real rate.

interest. As interest rate goes up, the gap will be closed through higher saving and lower demand for loan capital, and a new equilibrium will be reached. As adjustment in the loan capital market will not affect the equilibrium condition in the goods market, wages and prices will remain unchanged. The sum of money incomes remains the same as the money value of the consumption and capital goods although the composition of spending shifts towards capital goods.

Wicksell then distinguished between the natural rate of interest and the interest rate charged by the banks for loans, here referred as market interest rate. Although the banks' ability to extend credit or loans is limited by their reserves, the banking system with a central bank that can create reserves can extend credit to satisfy any demand for loans at any rate of interest.

2.1.2 Cumulative Process of Price Changes

If the banks charge a rate lower than the natural rate, saving will be discouraged and thus demand for current consumption will increase. On the other hand, a lower interest rate will make more investment opportunities profitable on the part of the entrepreneurs, therefore demand for capital goods will go up. Equilibrium in the market for goods and services will therefore be disturbed. Given that all productive factors are already fully employed, the increase in demand for goods and services raises the prices for all inputs and thus increases the
income of all resource owners. An increase in income will generate a further increase in the demand for goods and services. The rise in prices will continue so long as the market rate of interest remains below the natural rate. Expected higher prices in the future will increase the profitability of capital goods despite higher prices being paid to all input owners because entrepreneurs are still able to borrow from banks at a rate lower than the natural rate. As entrepreneurs bid up the prices of all inputs, they indirectly force up the price of consumption goods even further because of the higher incomes earned by all input owners. Even if the bank rate moves back to the normal rate, the expectation of higher output prices in the future will still cause the entrepreneurs to offer the same high price to input owners because the higher income of the input owners will have raised the demand for goods and services.

Adjustments will occur in the opposite direction if the banks choose to lend at a market rate above the natural rate of interest. Higher interest rates stimulate saving and therefore decrease demand for goods and services. It also discourages demand for loan capital as higher interest rates make fewer investment opportunities profitable. Lower demand for goods and services will reduce prices for all inputs and thus the income of all input owners will fall. Lower income of input owners will further decrease the demand for goods and services. Output prices will fall as a
result of the decrease in demand for goods and services. Lower product prices reduce the profitability of capital goods despite lower prices being paid to all input owners because they can borrow from the banks only at an interest rate higher than the natural rate. As demand for loan capital decreases, output prices will fall further following the same process of adjustment. This process of adjustment will be repeated indefinitely lowering the price level continuously so long as the market rate is maintained above the natural rate of interest.

The consequence of maintaining a market rate of interest below the natural rate will be a continuous rise in the price level, while maintaining a market rate of interest above the natural rate will cause a continuous fall in the price level. There will be no tendency for the price level to come back to the initial level. Instead it will move farther and farther away so long as the market rate of interest does not coincide with the natural rate. If at any time, the difference between the market and the natural rate of interest disappears, the price level will cease to change and will remain at its new level.

Fluctuations in output prices can also be explained by changes which occur from time to time in the natural rate of interest. Even though the monetary authority may not set out to peg the market rate of interest at a level which differs from the natural rate, the discrepancy between the
market rate and the natural rate of interest may arise due to the fact that the market rate does not adjust fast enough to changes in the natural rate. If for any reason, the natural rate of interest increases, for a while the market rate of interest will remain unchanged. The market rate will then be less than the natural rate creating a discrepancy which generates the process of continuous inflation as described before. The process of adjustment will continue until the market rate of interest increases to the level of the natural rate. If for any reason, the natural rate of interest decreases, continuous deflation develops and will stop only when the market rate of interest falls until it coincides with the natural rate of interest. The lag in the adjustment of the market rate to the natural rate helps to explain the fact that historically rising prices and rising interest rates often go together. It is thus not the level of the market rate that matters, but its relation to the natural rate of interest.

2.1.3 The Role of Price Expectations

Wicksell assumes that entrepreneurs anticipate future prices to be the same as present ones. However, Friedman in his 1968 presidential address to the American Economic Association,\(^3\) traced the cumulative process of price fluctuations through changes in the natural rate of interest.

caused by changes in inflationary expectations. The monetary authority can make the market rate of interest lower than the natural rate of interest for a time by creating excess money supply and thereby raising inflation, but this is a knife-edged equilibrium if people form their price expectations adaptively. As prices go up, people will expect higher future inflation. When anticipations of inflation become widespread, the Fisher effect\(^4\) sets in, and borrowers will then be willing to pay and lenders will demand higher interest rates. The natural rate of interest will be raised and that requires an even greater excess supply of money to keep the market rate of interest from rising. To keep the market rate of interest below the natural rate, the monetary authority must expand money supply at even higher rates. Conversely, to keep the market rate of interest above the natural rate, the monetary authority has to decrease the money supply at faster and faster rates because the natural rate of interest will fall as the expected rate of deflation increases. Since the natural rate of interest is not observable, the interest-pegging policy is doomed one way or another.

\(^4\) The nominal interest rate is equal to the sum of the real interest rate and the expected rate of inflation.
2.1.4 An Illustration of Cumulative Process with Adaptive Expectations

Assume the economy will be at flow equilibrium\(^5\) at an interest rate of 5 percent which is also the natural rate, and the expected rate of inflation is zero. As shown in Figure 2.1, \(i_n = 5\%\) when demand for loan capital is the same as the supply of loan capital. If the monetary authority now pegs the interest rate below the natural rate, say \(i_m\), there will exist an excess demand for loan capital, \(I+(G-T)+(X-M)\) exceeds \(S\) by \(L_tL_3\) and total planned expenditures on goods and services will now be greater than the total aggregate output in the economy. Prices go up because of the excess demand for goods and services. The monetary authority has to create an excess supply of money\(^6\) amounts to \(L_tL_3\) in order to prevent the interest rate from rising. The monetary authority can do so by expanding the money supply. The monetary expansion first generates the liquidity effect which expands the money income, and then followed by the income effect which raises the money

\(^5\) Flow equilibrium requires \(Y = C + I + G + (X-M)\) which states that aggregate output is the same as planned aggregate expenditures in the economy. This condition also implies \(S = I + (G-T) + (X-M)\) which the economy exists no excess supply or demand for loan capital.

\(^6\) The current money supply minus the quantity of money demanded.
FIGURE 2.1: CUMULATIVE PROCESS WITH ADAPTIVE EXPECTATIONS
demand. The increase in money demand now reduces the amount of excess supply of money that the monetary authority has previously generated. In order to prevent the interest rate from rising, the monetary authority has to undergo further monetary expansion to recreate the required excess supply of money. In addition to the liquidity and the income effects, after a while expectations of inflation start to increase. If prices go up at a rate of 10 percent per year, due to adaptive expectations people will adjust their future expectations upwards and eventually $\pi_t = 10\%$.

As saving and investment decisions are both functions of inflationary expectations, higher inflationary expectations will discourage saving and stimulate investment at any given nominal rate of interest. The natural rate of interest will be pushed to a higher level, $i_n$, which is 15 percent. The excess demand for loan capital at the pegged rate, $i_m$, will now increase to $L_1L_4$. The monetary authority now has to create an even larger excess supply of money. Accelerated monetary expansion which causes runaway inflation is inevitable not only to keep up with the income effect on

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7 Money Demand is assumed to be proportional to money income as defined in the Cambridge equation where $M^d = kyP$.

8 The interest rate is expressed as a continuously compounded rate so that the nominal rate of interest will be equal to the sum of the real rate (here referred to as the natural rate) and the expected rate of inflation, $i_n = i_n + \pi_t$. 28
money demand but also the ever rising natural rate of interest and widening gap of excess demand for loan capital.

2.2 ANOTHER LOOK AT THE PRICE-PEGGING ERA

2.2.1 Postwar Inflation

When rationing and price control were lifted by the end of 1946, people were able to use their money balances to purchase consumer durables which were not produced at all during the war years. Saving decreased and demand for goods and services went up, as shown in Figure 2.2, the natural rate of interest increased from $i_n$ to $i'_n$, which widened the divergence between the pegged market rate and the natural rate of interest. The higher natural rate of interest resulted in a larger gap of excess demand for loan capital ($L_1L_3$ instead of $L_2L_3$). The Fed's commitment to peg the fixed pattern of rates required the Fed to supply the liquidity necessary to keep the interest rate from rising. The Fed managed to do so by purchasing government securities in the open market.

The cumulative inflation would have been worse if the public had not perceived the price rise as a once-and-for-all adjustment to the suppressed inflation produced by the price controls. The fact that the public did not expect the inflation to continue made the natural rate of interest lower than it would have been had the public formed their expectation of inflation adaptively.
FIGURE 2.2: POSTWAR INFLATION 1946-48
2.2.2 1948-49 Recession

The economy began to slow down in the second half of 1947. After the backlog of demand for consumer durables had been satisfied, consumer expenditures began to fall and as did the demand for goods and services. Government spending also started to fall after the expiration of wartime contracts. With this decline in domestic spending, together with the decline in exports due to depletion of international reserves by European countries, income started to fall. As the natural rate of interest fell, the Fed’s commitment to peg the market rate of interest which was above the natural rate forced the Fed to sell government securities in the open market to prevent the interest rate from falling and the cumulative process of deflation started to operate. In addition to the income and liquidity effects, deflationary expectations produced by fears of a resumption of depression following the artificial stimulus of the war pushed the natural rate even further below the market rate of interest. As shown in Figure 2.3, deflationary expectations which encouraged saving and discouraged investment along with the decline in government spending and exports reduced the natural rate of interest from \( i_n \) to \( i'_n \). Pegging the market rate at \( i_m \) which was then above the natural rate generated a continuous fall in commodity prices which the economy experienced from 1948 to 1949.
FIGURE 2.3: 1948-49 RECESSION
2.2.3 Korean War Inflation

The outbreak of the Korean War generated a buying spree and inflationary expectations in the economy and consumer expenditures surged. Output prices went up. Inflationary expectations raised the natural rate of interest from $i_n$ to $i'_n$, widening the difference between the market rate, $i_m$, and the natural rate of interest, as shown in Figure 2.4. It also increased expected returns on future capital given the fact that investors could borrow at lower real rates of interest. The demand for loan capital increased and as did the prices of all inputs and income of these owners. Output prices went up further and the cumulative process of price increase continued. To continue to peg interest rate at $i_m$, the Fed had to generate all necessary excess supply of money at the pegged level. The Fed could pursue this commitment only by greater and greater open market purchases of government securities as the excess demand for loan capital increased from $L_3$ to $L_4$. As people realized that there had been an increase in prices, they perceived the upward trend in prices would carry forward to the future. Through adaptive expectations, higher prices for the current period generates higher inflationary expectations for the next period which will push the natural rate of interest up even further. In so doing, the Fed acted as an "engine of
FIGURE 2.4: KOREAN WAR INFLATION
This process of cumulative inflation ceased only after the first quarter of 1951 when the Treasury-Federal Reserve Accord came into effect.

2.2.4 Treasury-Federal Reserve Accord

The official abandonment of the price-pegging policy completely changed the environment in financial markets. Interest rates were now allowed to adjust to market conditions. Since the prevailing market rate before the Accord was below the natural rate, interest rates were bound to go up after the Accord and did. As the market rate adjusted upward towards the natural rate, the cumulative process of inflation ceased. Not only did the price increase stop, prices actually began to fall. The monetary expansion went on, however, at an even faster pace.

We can explain the experience after the Accord, lower prices along with accelerating monetary expansion, using the loanable funds model. Since the increase in monetary growth did not produce inflation and if the loanable funds model applies in this period, the demand for money must have increased. This shift in the demand for money fills in the missing link between the paradoxical observation of a deceleration in inflation and an acceleration in monetary growth after the Accord. As people’s demand for money

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balances went up, offsetting the increase in the money supply, the demand for goods and services did not increase.

When the Fed declared its independence from the price-pegging policy, the public realized that the monetary authority would not continue to feed the economy with cheap money. The revival of the Fed's independent monetary policy also reassured the public of the Fed's ability to strive for price stability. As people lowered their expectations of future price increases, the natural rate of interest decreased from $i_n$ to $i_n'$, as shown in Figure 2.5. The increase in market interest rates from 2-1/2 percent to 2-3/4 percent after the Accord, together with the fall in the natural rate of interest caused by lower inflationary expectations, eliminated the excess demand for loan capital. The excess demand for loan capital of $L_1'L_4$ disappeared. The fact that the acceleration in the rate of monetary growth did not generate inflation must have been due to an increase in demand for money balances if the loanable funds model holds true for the period. In the next section, we will develop an explanation for the shift in the demand for money.
Interest Rate (%)

\[ i'' = 2*4 \]

Loanable Funds

FIGURE 2.5: TREASURY-FEDERAL RESERVE ACCORD

\[ S(\pi^e) \]

\[ I(\pi^e) + (G-T) + (X-M) \]

\[ i_n = i_m = 2\frac{3}{4} \]

\[ 2\frac{1}{2} \]
2.3 DEMAND FOR MONEY

2.3.1 Tobin's Liquidity Preference Model

Tobin in his classic article\textsuperscript{10} analyzed the choice between holding money balances and government bonds. He first identified two reasons for holding money balances: transactions reasons and investment reasons. Transactions balances arise to meet excess expenditures over receipts. The size of these balances depends on the institutional arrangements of the society which then determines the synchronization between individual receipts and expenditures. Given these institutional determinants of demand for transactions balances, its size is roughly proportional to the aggregate volume of transactions and has shown to be inversely related to the rate of interest.\textsuperscript{11} Investment balances which Keynes referred as the speculative demand for money can be made up of cash or other alternative financial assets. The alternative financial asset is marketable and free of default risk, and Tobin used government bonds in his analysis. Portfolio decisions thus involve the allocation of wealth between money balances and government bonds.


As the market value of bonds are inversely related to the current rate of interest, bond holders will receive capital gains or losses in addition to the fixed coupon yield of the bonds if interest rates change. Since money balances bear no nominal return, holding money balances for investment reasons must be due to the expectation or fear of loss in bonds. Keynes' Liquidity Preference theory postulates a negative relationship between the rate of interest and speculative demand for money balances due to different expectations of future interest rates among investors. When interest rates are low, people tend to expect interest rates to rise in the future when they will incur capital loss on their bonds. Therefore they will convert their bonds into money balances to avoid anticipated capital loss. As they sell their bonds, bond prices will fall while interest rates will increase. When more and more people expect bond prices to fall, the demand for money increases. Keynes failed to consider the fact that bond prices already reflect expectations. Tobin reformulated the speculative demand for money in terms of a new portfolio allocation theory pioneered by Markowitz\(^{12}\) which analyzed portfolio choice in terms of probability density function of expected returns.

An investor who is uncertain about the future rate of interest will face a risk of capital gains or losses on his holdings of bonds. Tobin used the standard deviation of expected returns on bonds as a measure of bond risk, \( \sigma_g \). The expected returns on bonds include the coupon interest yield and the capital gains or losses of holding bonds. The standard deviation is a measure of the dispersion of possible returns around the mean expected value. The risk associated with the portfolio is measured by the standard deviation of the portfolio return, \( \sigma_p \), which in turn depends on the bond risk, \( \sigma_g \). The higher the proportion of bonds in the portfolio, the more risk the investor assumes. Tobin is then able to analyze the impact on the demand for money balances of changes in the interest rate and changes in bond risk respectively. First, even if the current rate of interest remains constant, a change in the risk associated with holding bonds will cause a change in the portfolio composition. Secondly, the attitude of investors towards risk will result in different portfolio compositions given the same interest rate and portfolio risk. Tobin identified two types of behavior towards risk, those who are averse to risk and those who love risk. His maximization model explains the shift in the portfolio composition between money balances and bonds using the opportunity locus and indifference curves depicting the tradeoff between expected portfolio return and portfolio risk.
For example, an investor holds a proportion $\gamma$ of wealth in bonds and $(1-\gamma)$ in money balances. The portfolio risk increases with the proportion of the portfolio held in bonds. When the investor chooses to hold all the wealth in bonds, that is $\gamma = 1$, the portfolio risk will be the same as bond risk, $\sigma_R = \sigma_i$. When the investor chooses to hold all his wealth in money balances, $\gamma=0$, portfolio risk becomes zero as money balances incur no risk as far as nominal values are concerned. If we assume capital gains and losses are a random variable and expected value of capital gains or losses equals zero, the expected portfolio return will be equal to the proportion of wealth in bonds, $\gamma$, times the coupon rate of interest, $i\%$. Given the rate of interest, the higher the proportion of bonds in the portfolio, the higher will be the portfolio risk and the expected portfolio returns. The opportunity loci of expected portfolio returns is a positive linear function of portfolio risk passing through the origin, as shown in Figure 2.6. As the rate of interest increases, the expected portfolio return associated with each level of risk increases accordingly, and the opportunity line rotates counter-clockwise.

The slope of the indifference curves defines the risk preference of individual investors. Each indifference curve depicts different combinations of portfolio risk and expected portfolio returns which give the individual investor the same level of utility. A risk-lover has
FIGURE 2.6: OPPORTUNITY LOCUS
indifference curves that are downward sloping. This type of investor is willing to assume more risk even if the expected portfolio return falls in order to secure a chance of getting unusual large returns. The optimum solution for risk lovers is to hold all their wealth in bonds, as shown in Figure 2.7.

Risk-aversers have upward sloping indifference curves. To compensate these risk-aversers for any additional risk, the expected portfolio return must rise. Tobin then distinguished two types of risk-aversers. The first type are diversifiers who hold both money balances and government bonds and will respond to any changes by increasing the proportion of either money balances or bonds in the portfolio, as shown in Figure 2.8. The other type of risk averters are plungers. These investors always invest all their wealth in only one type of asset, either money balances or bonds, as shown in Figure 2.9. Therefore, these investors might respond to changes by shifting all their wealth from money balances to bonds, from bonds to money balances, or by maintaining the current portfolio.

For a diversifier, given the same bond risk, a higher interest rate will shift the opportunity line counterclockwise, as in Figure 2.10, from OB₁ to OA₁. Given that \( \gamma_i^{A,i} \) is higher than \( \gamma_i^{B,i} \), \( \gamma_i^A \) can be greater than or less than \( \gamma_i^B \). If \( \gamma_i^A \) is greater than \( \gamma_i^B \), then there is an increase in the proportion of bonds in the portfolio due to
FIGURE 2.7: RISK-LOVERS
FIGURE 2.8: RISK-AVERTERS - DIVERSIFIERS
FIGURE 2.9: RISK-AVERTERS - PLUNGERS
FIGURE 2.10: INCREASE IN INTEREST RATE
a higher interest rate, and therefore a corresponding
decrease in demand for money balances. However, if $\gamma^A_i$ is
less than $\gamma^B_i$, then there is a decrease in the proportion of
bonds in the portfolio due to a higher interest rate, and
therefore a corresponding increase in demand for money
balances. This can be resolved by looking at the
substitution and income effects in the theory of choice. An
increase in interest rate increases the return on bonds,
other things being constant, and therefore it will increase
the proportion of bonds in the portfolio. The substitution
effect allows for higher expected return only along with
higher risk. However, an increase in income due to higher
rate of interest allows the investor to enjoy higher
expected returns with each and every level of risk assumed.
His positive income effect together with the positive
substitution effect conclude an increase in demand for bonds
and the corresponding decrease in demand for money balances.

On the other hand, given the same interest rate, an
increase in bond risk will decrease the expected returns on
bonds. The substitution effect allows lower expected
returns with lower risk. The income effect, on the other
hand, also results in lower expected returns with each and
every level of risk assumed. In this case, both
substitution and income effects are negative causing the
proportion of bonds in the portfolio to fall. As shown in
2.11, the opportunity line shifts clockwise from $OB_2$ to $OA_2$. 

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FIGURE 2.11: INCREASE IN BOND RISK
As $\gamma^A$ is lower than $\gamma^B$, there is a decrease in the proportion of bonds in the portfolio due to an increase in bond risk, therefore a decrease in demand for bonds and a corresponding increase in demand for money balances.

Now, let us look at the changes brought about by the Accord in the context of Tobin's model. In figure 2.12, the opportunity line for portfolio risk and expected portfolio return before the Accord is shown by OB when the interest rate was pegged at 2-1/2 percent. The expected portfolio return equals 2-1/2 percent when $\gamma=1$ and the portfolio risk $\sigma_R$ becomes the same as the bond risk $\sigma_x$. After the Accord, interest rate increased to 2-3/4 percent but the risk associated with holding bonds also increased. If the increase in bond risk is sufficiently large, the slope will decrease despite the higher interest rate. The slope of the opportunity line decreased representing lower expected portfolio return for each and every level of portfolio risk due to higher bond risk after the Accord, and the opportunity line becomes OA. The indifference curves are depicted concave upwards representing increasing risk aversion as the proportion of bonds in the portfolio increases. Since the Treasury exchanged all outstanding bonds with new bonds of higher yield, investors did not suffer capital loss immediately following the Accord due to higher interest rates. The higher interest rates should encourage investors to hold more bonds. However, at the
FIGURE 2.12: CHANGES FOLLOWING THE ACCORD
same time, the abandonment of price-pegging increases the bond price volatility and therefore increase the risk of capital gains or losses. Higher bond risk increases portfolio risk accordingly and therefore makes holding of bonds less desirable. When this negative bond risk effect was sufficiently large enough to outweigh the positive interest rate effect, there would be a decrease in the proportion of bond-holding and corresponding increase in the demand for money balances. We then conclude from the equilibrium positions before and after the Accord that the expected portfolio return decreased after the Accord and that could possibly happen only if $\gamma^A$ is greater than $\gamma^S$. A higher interest rate along with higher portfolio risk can decrease bond holding and thus increase the demand for money balances. Tobin successfully introduced the risk component in the discussion of demand for money balances in the context of portfolio choice approach. His approach, however, was not able to arrive at unambiguous conclusion on the change in demand for money balances following the Accord without making qualifying assumptions.

2.3.2 Walsh's Money Demand Function

Walsh's study\textsuperscript{13} on the change in the operating procedure from federal funds rate targeting to non-borrowed

\textsuperscript{13} Walsh, Carl E., "Interest Rate Volatility and Monetary Policy," Journal of Money, Credit, and Banking, May 1984, vol. 16, no. 2, pp. 133-150.
reserves targeting by the Federal Reserve in 1979 concluded that the higher volatility of interest rate has increased the demand for money as well as decreased the interest elasticity of money demand. He explicitly derived the demand for money function by maximizing the risk adjusted return of a portfolio. This approach resolves the ambiguity of the maximization procedure that Tobin adopted. Walsh is able to demonstrate the unambiguous negative effect on the demand for money balances due to the change in the rate of interest, and the positive relationship between the demand for money balances and the bond risk for risk averters. The variance of returns on bonds is used as a measure of bond risk. Based on his formulation, we can derive the following relationship between the risk of holding bonds measured by the volatility of interest rate and the demand for money.

Suppose, \( r_m \) = real return on money;
\[ r_b =\text{real return on bonds (which includes the coupon yield and capital gain or loss.)} \]

Real return on money can be expressed as the transactions services provided by real money balances (which is a function of output) less inflation. The real return on bonds is the nominal rate of return minus inflation.
\[ r_m = t_0 + ty - \pi \quad (2.1) \]
\[ r_b = i_b - \pi \quad (2.2) \]

Assume a normal distribution of inflation \( \pi \) and the nominal return on bonds \( i_b \), a distribution of \( \pi \) that has a
mean $\bar{\pi}$ and a variance of $\epsilon_r^2$, and a distribution of $\bar{i}_b$ that has a mean of $\bar{i}_b$ and variance of $\epsilon_i^2$. Equations 2.1 and 2.2 become:

\begin{align*}
r_m &= t_0 + t\gamma - \bar{\pi} - \epsilon_r \\
r_b &= \bar{i}_b - \bar{\pi} + \epsilon_i - \epsilon_r
\end{align*}

(2.3) \hspace{1cm} (2.4)

If people hold $\phi$ of their wealth in money and $(1-\phi)$ in bonds, the risk adjusted return on portfolio will be $r_p^*$:\(^{14}\)

\[
r_p^* = \phi(t_0 + t\gamma - \bar{\pi}) + (1-\phi)(\bar{i}_b - \bar{\pi}) + \rho[\phi(-\epsilon_i) + (1-\phi)(\epsilon_i - \epsilon_r)]^2
\]

(2.5)

where $\rho$ is the coefficient of risk aversion.\(^{15}\)

\[
r_p^* = \phi(t_0 + t\gamma - \bar{\pi}) + (1-\phi)(\bar{i}_b - \bar{\pi}) + \rho[(1-\phi)^2\epsilon_i^2 + \epsilon_r^2 - 2(1-\phi)\epsilon_i\epsilon_r]
\]

---

\(^{14}\) According to Walsh, the expected utility of wealth of next period, $EV(W_{t+1})$, can be written as a function of expected wealth, $E(W_{t+1})$, and the variance of expected wealth, $var(W_{t+1})$:

\[
EV(W_{t+1}) = J[E(W_{t+1}), var(W_{t+1})]
\]

If return on portfolio $r_p = W_{t+1}/W_t$ a function of choice variable $x$, the first order condition for maximizing $EV(W_{t+1})$:

\[
\frac{\partial J}{\partial E(W_t)} \cdot \frac{\partial E(r_p)}{\partial W_t} + \frac{\partial J}{\partial var(W_t)} \cdot \frac{\partial var(r_p)}{\partial W_t} = 0
\]

\[
J_1 \cdot \frac{\partial E(r_p)}{\partial x} + (J_2 W_t) / J_1 \cdot \frac{\partial var(r_p)}{\partial x} = 0
\]

The same first order condition can be obtained by maximizing the function: $E(r_p) + \rho var(r_p)$ if $\rho \geq (J_2 W_t) / J_1$.

\(^{15}\) $\rho$ depends on the ratio of the first derivative of expected utility of wealth with respect to risk and the first derivative of expected utility of wealth with respect to expected wealth. With every unit increase in expected wealth, the expected utility of wealth increases. $\rho$ tends to be negative for all investors if we assume expected utility of wealth falls with every unit increase in risk. However, the absolute of $\rho$ is lower for risk lovers than for risk averters.
\[ r_p^* = \phi(t_0 + ty - \bar{\pi}) + (1-\phi)(\bar{I}_b - \bar{\pi}) + \rho[(1-2\phi+\phi^2)\epsilon_i^2 + \epsilon_r^2] \]
\[
-2\epsilon_i\epsilon_r + 2\phi\epsilon_i\epsilon_r
\]
\[ = \phi(t_0 + ty - \bar{\pi}) + (1-\phi)(\bar{I}_b - \bar{\pi}) + \rho[\epsilon_i^2 - 2\phi\epsilon_i^2 + \phi^2\epsilon_i^2 + \epsilon_r^2] \\
-2\epsilon_i\epsilon_r + 2\phi\epsilon_i\epsilon_r
\]
\[ = \phi(t_0 + ty - \bar{\pi}) + (1-\phi)(\bar{I}_b - \bar{\pi}) + \rho\epsilon_i^2 - 2\rho\phi\epsilon_i^2 \\
+ \rho\phi^2\epsilon_i^2 + \rho\epsilon_r^2 - 2\rho\epsilon_i\epsilon_r + 2\rho\phi\epsilon_i\epsilon_r
\]

Maximize \( r_p^* \) with respect to \( \phi \),
\[
(t_0 + ty - \bar{\pi}) - \bar{I}_b + \bar{\pi} - 2\rho\epsilon_i^2 + 2\rho\phi\epsilon_i^2 + 2\rho\epsilon_i\epsilon_r = 0
\]
\[
(t_0 + ty - \bar{I}_b) - 2\rho\epsilon_i^2 + 2\rho\phi\epsilon_i^2 + 2\rho\epsilon_i\epsilon_r = 0
\]
\[-2\rho\epsilon_i^2 = t_0 + ty - \bar{I}_b - 2\rho\epsilon_i^2 + 2\rho\epsilon_i\epsilon_r
\]
\[
\phi^* = \frac{(t_0 + ty - \bar{I}_b + 2\rho\epsilon_i\epsilon_r)}{-2\rho\epsilon_i^2 + 1} \quad (2.6)
\]

Assuming \( \epsilon_i\epsilon_r = 0 \), then
\[
\phi^* = \frac{(t_0 + ty - \bar{I}_b)}{-2\rho\epsilon_i^2 + 1} \quad (2.7)
\]

The demand for money function is therefore equal to the equilibrium proportion of money balances in the portfolio times the amount of wealth, \( M^d = \phi W \). It depends on income, the nominal rate of return on bonds, the coefficient of risk aversion, and the variance of the expected rate of return on bonds. Other things being constant, a higher interest rate will raise the return on bonds, and will cause the proportion of money balances to fall. Higher interest rate volatility increases bond risk as measured by \( \epsilon_i^2 \). The higher the \( \epsilon_i^2 \), the higher the value of \( \phi \) and thus the higher the proportion of money balances in the portfolio. The more risk averse the investor is, the higher the absolute value of \( \rho \), and therefore the higher the value of \( \phi \) becomes.

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Before the Accord, $\epsilon_i^2$ was very low. As the rate of return on bonds was greater than return on money, the first term was negative and high absolute value. $\phi$ was therefore very small. However, after the Accord, $\epsilon_i^2$ went up because Federal Reserve was no longer committed to peg bond prices. Interest rate increased from 2-1/2 percent to 2-3/4 percent after the Accord. Higher interest rates would decrease the demand for money balances if $\epsilon_i^2$ had remained unchanged. But the first component of equation (2.7) would still be negative but lower in absolute value if the proportional increase in the denominator, $\epsilon_i^2$, was greater than that of the numerator, in absolute terms, given the same risk preference of investors. The variance of interest rates increased more than two times while the mean of interest rates increased 16-48 percent after the Accord.\(^\text{16}\)

Therefore, we may conclude that it is possible that $\phi$ would be higher after the Accord. Higher interest rate volatility, which corresponds to higher bond risk, increased the demand for money balances after the Accord given the same risk preference of investors. A decline in the velocity of money was actually observed immediately after the Treasury-Federal Reserve Accord of March 1951. We will

\begin{table}
\begin{tabular}{lllll}
\hline
\textit{Period} & \textit{MEAN}(i_T) & \textit{MEAN}(i_B) & \textit{VARIANCE}(i_T) & \textit{VARIANCE}(i_B) \\
\hline
47/1--51/3 & 1.02 & 2.33 & 0.077 & 0.009 \\
51/4--55/6 & 1.51 & 2.70 & 0.157 & 0.024 \\
\hline
\end{tabular}
\end{table}

where $i_T$ is the interest yield on three-month treasury bills and $i_B$ is the interest yield on long-term government bonds of maturity fifteen years and above.

\(^{16}\)
now examine the change in money demand after the Accord and proceed with an empirical testing of the factors which might have caused the change.
3.1 THE THREE QUALIFICATIONS
3.1.1 Disequilibrium in the Money Market

Since the quantity of money demanded is not an observable variable, the basic textbook approach to measuring money demand assumes that the demand for money is equal to the supply of money at every point in time. Only by assuming equilibrium in the money market can the quantity of money supplied be used to measure the quantity of money demanded. However, this traditional assumption did not hold in the money market during the price-pegging period. By committing itself to peg the long-term interest rate at 2-1/2 percent, the Federal Reserve was required to disrupt the money market from its equilibrium position when the interest rate consistent with flow equilibrium did not coincide with the pegged rate. The objective of the Fed was to create the necessary amount of excess money supply or excess money demand to prevent the rate of interest from rising or falling. The amount of excess money supply or money demand required was determined by the gap between the demand and supply of loanable capital. Therefore, if we ignore this qualification and apply the traditional approach to measuring the quantity of money demanded function during this period, we will in fact be measuring, in part, the
money supply function. Previous studies of estimating the money supply function left out important variables which determined the necessary excess money supply or money demand that the Fed was required to generate. Since the quantity of money demanded cannot be obtained directly from the quantity of money supplied, we cannot explicitly estimate the money demand function. We will specify a money supply function which includes money demand as an explanatory variable and test for a structural change in the demand for money following the Accord.

3.1.2 Money Supply was Partly Determined by Money Demand

Using the loanable funds model introduced in the last chapter, we can express the relationship of money supply to other economic variables for every time period \( t \) as follows:

\[
M'_t = I_t + FD_t + NX_t - S_t + M^d_t
\]  

(3.1)

where \( M' \) is the money supply;

- \( I \) is the gross private investment;
- \( FD \) is the federal deficits;
- \( NX \) is the net exports;
- \( S \) is gross saving; and
- \( M^d \) is the money demand.

---

3.1.3 Partial Adjustment of Money Demand

Partial adjustment models are often adopted in analysis of money demand applied to quarterly data. The rationale is that there exists portfolio adjustment costs, both pecuniary and non-pecuniary, that prevent a complete, immediate adjustment of actual money balances to desired levels. The formulation used in this study is similar to that proposed by Goldfeld:

\[ W_t - W_{t-1}^* = \lambda (W_{t-1}^* - W_{t-1}) \]

where \( W_t \) is the short-run demand for nominal money balances in period \( t \), \( W_{t-1}^* \) is the long-run desired nominal money balances in period \( t \), \( M_{t-1}^s \) is the money supply in period \( t-1 \), and \( \lambda \) is the rate of adjustment in which \( 0 < \lambda < 1 \). The short-run nominal demand for money is therefore defined as:

\[ M_t^d = \lambda M_{t-1}^d + (1-\lambda)M_{t-1} \tag{3.2} \]

The short-run nominal money demand is therefore a weighted average of the long-run desired nominal money balances and lagged nominal money supply.

3.2 THE STRUCTURAL EQUATIONS

We can now rewrite the loanable funds model equation (3.1) by substituting \( M_t^d \) with the partial adjustment model equation (3.2):

\[ \]

Let us define investment, saving, and long-run money demand functions for time period $t$ as follows:

\[ I_t = I_t(i_t, \pi^e_t, Y_t, g_t); \]
\[ S_t = S_t(i_t, \pi^e_t, Y_t, g_t); \]
\[ M^*_{t-1} = M^*_{t-1}(i_t, \pi^e_t, Y_t). \]

where $i$ is the rate of interest;
$\pi^e$ is the expected rate of inflation;
$Y$ is the total output; and
g is the economic growth rate.

For simplification, we specify the structural equations in linear forms:

\[ I_t = \alpha_1 + \beta_{11} i_t + \beta_{12} \pi^e_t + \beta_{13} Y_t + \beta_{14} g_t \quad (3.4) \]
\[ S_t = \alpha_2 + \beta_{21} i_t + \beta_{22} \pi^e_t + \beta_{23} Y_t + \beta_{24} g_t \quad (3.5) \]
\[ M^*_{t-1} = \alpha_3 + \beta_{31} i_t + \beta_{32} \pi^e_t + \beta_{33} Y_t \quad (3.6) \]

Substituting equations (3.4), (3.5), and (3.6) into equation (3.3), the money supply equation becomes:

\[ M_t = \alpha + \beta_1 i_t + \beta_2 \pi^e_t + \beta_3 Y_t + \beta_4 g_t + \beta_5 FD_t + \beta_6 NX_t + \beta_7 M_{t-1} \quad (3.7) \]

where $\alpha = \alpha_1 - \alpha_2 + \lambda \alpha_3$;
$\beta_1 = \beta_{11} - \beta_{21} + \lambda \beta_{31}$;
$\beta_2 = \beta_{12} - \beta_{22} + \lambda \beta_{32}$;
$\beta_3 = \beta_{13} - \beta_{23} + \lambda \beta_{33}$;
$\beta_4 = \beta_{14} - \beta_{24}$;
$\beta_5 > 0$;
\[ \beta_6 > 0; \text{ and} \]
\[ \beta_7 = 1 - \lambda. \]

### 3.3 EXPECTED SIGNS OF PARAMETERS

#### TABLE 3.1 EXPECTED SIGNS OF PARAMETERS

<table>
<thead>
<tr>
<th>Equation:</th>
<th>3.4</th>
<th>3.5</th>
<th>3.6</th>
<th>3.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent Variables</td>
<td>I</td>
<td>S</td>
<td>M^d</td>
<td>M^f</td>
</tr>
<tr>
<td>Independent Variables</td>
<td>( \beta_{1i} &lt; 0 )</td>
<td>( \beta_{2i} &gt; 0 )</td>
<td>( \beta_{3i} &lt; 0 )</td>
<td>( \beta_i = (-) - (+) + (-) &lt; 0 )</td>
</tr>
<tr>
<td>( \pi^c )</td>
<td>( \beta_{12} &gt; 0 )</td>
<td>( \beta_{22} &lt; 0 )</td>
<td>( \beta_{32} &lt; 0 )</td>
<td>( \beta_2 = (+) - (-) + (-) = ? &gt; 0 )</td>
</tr>
<tr>
<td>( Y )</td>
<td>( \beta_{13} &gt; 0 )</td>
<td>( \beta_{23} &gt; 0 )</td>
<td>( \beta_{33} &gt; 0 )</td>
<td>( \beta_3 = (+) - (+) + (+) = ? &gt; 0 )</td>
</tr>
<tr>
<td>( g )</td>
<td>( \beta_{14} &gt; 0 )</td>
<td>( \beta_{24} &gt; 0 )</td>
<td>( \beta_4 = (+) - (+) = ? &gt; 0 )</td>
<td></td>
</tr>
<tr>
<td>( FD )</td>
<td>( \beta_5 &gt; 0 )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( NX )</td>
<td>( \beta_6 &gt; 0 )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( M_{t-1} )</td>
<td>( \beta_7 = (1 - \lambda) &gt; 0 )</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

An increase in the interest rate will encourage saving, and discourage investment. Other things being constant, the necessary amount of excess supply of money required to keep interest rate from rising will be reduced, or in other words, money supply will not have to increase as fast as before. Higher interest rates will also increase the opportunity cost of holding money balances producing a
decline in the demand for money. We therefore expect the interest rate to be negatively related to money supply.

Higher inflationary expectations make more investment opportunities profitable and therefore increase investment. Higher inflationary expectations also encourage substitution of future consumption for current consumption, and therefore decrease saving. Thus an increase in inflationary expectations require an increase in the excess supply of money to keep the interest rate from rising. On the other hand, inflationary expectations reduce the demand for money. The sign of the coefficient therefore depends on whether the effects on saving and investment outweigh the effect on the demand for money.

If \( \lambda|\beta_{32}| > |\beta_{12}| + |\beta_{22}| \) then \( \beta_2 < 0 \);

\( \text{if } \lambda|\beta_{32}| = |\beta_{12}| + |\beta_{22}| \) then \( \beta_2 = 0 \); and

\( \text{if } \lambda|\beta_{32}| < |\beta_{12}| + |\beta_{22}| \) then \( \beta_2 > 0 \).

Since the value of \( \lambda \) lies between zero and one, the combined effect of inflationary expectations on saving and investment is very likely to be greater than a proportion of the effect of inflationary expectations on money demand, therefore we can expect \( \lambda|\beta_{32}| < |\beta_{12}| + |\beta_{22}| \), and \( \beta_2 > 0 \).

While higher income has positive effect on investment, money demand, and saving, its effect on money supply is indeterminate.
If \(|\beta_{23}| > |\beta_{13}| + \lambda|\beta_{33}|\) then \(\beta_3 < 0\);

if \(|\beta_{23}| = |\beta_{13}| + \lambda|\beta_{33}|\) then \(\beta_3 = 0\); and

if \(|\beta_{23}| < |\beta_{13}| + \lambda|\beta_{33}|\) then \(\beta_3 > 0\).

Assuming the combined effect of income on investment and a proportion of that on money demand is greater than the effect of income on saving, then \(|\beta_{23}| < |\beta_{13}| + \lambda|\beta_{33}|\), and \(\beta_3 > 0\).

Higher income growth rate relates positively with both investment and saving, however, its effect on money supply is indeterminate.

If \(|\beta_{24}| > |\beta_{14}|\) then \(\beta_4 < 0\);

if \(|\beta_{24}| = |\beta_{14}|\) then \(\beta_4 = 0\); and

if \(|\beta_{24}| < |\beta_{14}|\) then \(\beta_4 > 0\).

Assuming the effect of income growth rate on investment is greater than that on saving, then \(|\beta_{24}| < |\beta_{14}|\), and \(\beta_4 > 0\).

Federal deficits and net exports are positively related to money supply. Any increase in deficit financing of government spending or increase in net exports will result in an increase in demand for loanable capital. Other things remain constant, both of these exogenous shocks will push the natural rate of interest to a higher level. The Fed's commitment to prevent the rate of interest from rising would require a larger supply of money.

The coefficient of the lagged money supply variable is equal to one minus \(\lambda\), and \(\lambda\) lies between zero and one. Therefore it is quite certain that the parameter of lagged
money supply also lies between zero and one. From the estimate of $\beta_s$, we can estimate $\lambda$, the rate of adjustment from the current money holdings to the desired level of money balances.

3.4 METHODOLOGY

We cannot measure the quantity of money demanded and thus cannot estimate the money demand function explicitly for the price-pegging period. However, by applying the loanable funds model, we can specify the money supply function which is dependent upon variables that determine the flow equilibrium and money demand. We therefore use the money supply function to test for a structural change in the parameters and deduce the effect on the demand for money function.

The money supply equation (3.7) will be estimated by the Ordinary Least Square (OLS) method. The single equation model allows us to use the OLS method so long as all the independent variables are exogenous. First, we want to find out if the coefficients turn out with the signs we expect in Table 3.1. Secondly, we apply t-test to individual coefficients and test the hypothesis if they are equal to zero. We also apply F-test to the regression equation and test if all coefficients are equal to zero. Thirdly, the test for serial correlation will not be valid using the Durbin-Watson statistic as one of the regressors include the
lagged dependent variable. We will calculate the Durbin-h statistic and compare it with the normal statistic to test if we can reject the hypothesis that there is no first order serial correlation in the regression equation. We would also want to take into account the number of regressors introduced in the equation in relation with the number of observations before we use the $R^2$ statistic and examine the goodness of fit of the regression equation. We therefore calculate the adjusted $R^2$, and use $\bar{R}^2$ to examine the overall goodness of fit.

In order to verify the application of the model during the price-pegging era, we would expect significant coefficients for variables federal deficit and net exports. These are the variables that other money supply functions failed to incorporate to account for the endogeneity of the Fed’s monetary action during the period of price-pegging era.

3.4.1 Dummy Variable

Since we have exact information on when the change in operating procedure had taken place, we can therefore divide the observations into two sub-samples - observations before the Accord of March 1951 and observations after the Accord of March 1951. Dummy variable, D, will be created to test for the impact on the constant term of the money supply function caused by a specific change in the Fed’s operating procedure - the removal of the price-pegging commitment.
D = 0 for pre-Accord observations; and
D = 1 for post-Accord observations.

As suggested by Walsh, the change in the operating procedure which induces higher volatility in interest rates will cause the interest elasticity of money demand to fall. To test whether this model confirms Walsh's conclusion, we introduce another variable Di, which is the dummy variable times the long-term interest yield, in addition to D, and estimate the money supply equation again.

3.4.2 Test for Structural Change

We therefore estimate the following equation to test for the structural change:

\[ M' = \alpha_i + \beta_1'i + \beta_2'i^2 + \beta_3'i^3 + \beta_4'Y + \beta_5'g + \beta_6'FD + \beta_7'NX + \beta_8'M_{i1} + \beta_9'D + \beta_{10}Di \] (3.8)

Since there were no major incidents occurred from 1947 to 1955 to suggest any structural shifts in investment and saving functions, we can imply any structural shifts in the money supply equations to be caused by a structural shift in the money demand function. The t-tests of parameters \( \beta_8 \) and \( \beta_9 \) of equations (3.8) will indicate the significance of whether these two parameters are individually different from zero. We will also apply Chow Test to test jointly these two parameters. The null hypothesis then becomes \( \beta_8 = \beta_9 = \)

---

0. The test will conclude the significance of whether these two estimates are jointly different from zero. We can therefore use the estimates of $\beta_s$ and $\beta_s$ to determine the change in the money demand after the Accord.
4.1 EMPIRICAL DATA

4.1.1 Number of Observations

Observations before first quarter of 1947 were not used because price controls were still in effect until the end of 1946. The economy experienced both a recession and a recovery for the two sub-periods: from the first quarter of 1947 to the Accord and from the Accord to the second quarter of 1955. Therefore, quarterly data from the first quarter of 1947 to the second quarter of 1955 will be used for regression analysis. Altogether there will be 34 observations, 17 pre-Accord observations from the first quarter of 1947 to first quarter of 1951, and 17 post-Accord observations from second quarter of 1951 to the second quarter of 1955.

4.1.2 Dependent Variables

Data for the money supply are adopted from Friedman and Schwartz. With the monthly seasonally adjusted money supply data available from the source, quarterly data are calculated from the monthly averages of the quarter. Both

\footnote{Data for the purpose of regression analysis are included in Appendices, Table A.1, p. 82.} 


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the narrow and the broader definitions of the money supply will be estimated by the model. The narrow definition of money supply M1 includes currency and demand deposits, while M2, a broader measure of money supply, includes saving deposits and time deposits of small denominations.

4.1.3 Independent Variables

Only long-term interest rates will be included in the estimation because the focus of the study is on the interest pegging policy and the substitution between money balances and government bonds. Interest yield on government bonds of maturity fifteen years and above will be used as the interest rate variable, i. The data are available monthly in the Federal Reserve Bulletin. Quarterly data are obtained by taking the averages of the monthly observations for the quarter concerned.

Inflationary expectations are formulated by the following:

\[(\Delta P/P)_t = \pi_t\] for every time period t

where people expect the rate of change in consumer prices reflects the future rate of inflation. Data on consumer price index are obtained from Survey of Current Business. Quarterly observations are the averages of the monthly observations for the quarters.

Gross national product data, Y, are available on a quarterly basis in the National Income and Product Accounts. They are seasonally adjusted annual rates in nominal terms.
Data on gross national product in real terms are also available from the National Income and Product Accounts. Real income growth rates, $g$, are obtained from rate of change in the gross national product in constant dollars.

The National Income and Products Accounts also provide data for federal deficit, $FD$, and net exports, $NX$. Federal deficits are government expenditures less government receipts. Net exports are exports less imports of goods and services, they are all in nominal terms, and seasonally adjusted.

4.2 EMPIRICAL RESULTS

4.2.1 Test of Loanable Funds Model

All estimated parameters turn out the correct signs as expected, as shown in Table 4.1. The t-statistics are shown in parenthesis. All coefficients are significantly different from zero except $\beta_5$ of $M_1$ which is the parameter for federal deficit. The F-statistics allow us to reject the null hypotheses and all regression coefficients of both equations are all significantly different from zero.

The interest rate variable is negative and significant. Given that other things remain unchanged, a higher rate of interest would require the Fed to slow down monetary growth in order to reduce the level of excess money supply when the market rate was below the natural rate or raise the level of
**TABLE 4.1: TEST OF LOANABLE FUNDS MODEL**

Dependent Variables  
(Equation: 3.7)

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Parameters</th>
<th>M1</th>
<th>M2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>-1.87**</td>
<td>-2.10**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-2.45)</td>
<td>(-2.30)</td>
</tr>
<tr>
<td>$\pi^c$</td>
<td>$\beta_2$</td>
<td>0.25**</td>
<td>0.32**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.12)</td>
<td>(2.31)</td>
</tr>
<tr>
<td>$Y$</td>
<td>$\beta_3$</td>
<td>0.04**</td>
<td>0.04**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(4.39)</td>
<td>(4.06)</td>
</tr>
<tr>
<td>$g$</td>
<td>$\beta_4$</td>
<td>0.18**</td>
<td>0.20*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.08)</td>
<td>(2.05)</td>
</tr>
<tr>
<td>FD</td>
<td>$\beta_5$</td>
<td>0.03</td>
<td>0.05*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.15)</td>
<td>(2.01)</td>
</tr>
<tr>
<td>NX</td>
<td>$\beta_6$</td>
<td>0.20**</td>
<td>0.23**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(4.24)</td>
<td>(4.46)</td>
</tr>
<tr>
<td>$M_{t-1}$</td>
<td>$\beta_7$</td>
<td>0.87**</td>
<td>0.93**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(17.6)</td>
<td>(28.9)</td>
</tr>
<tr>
<td>CONSTANT</td>
<td>$\alpha$</td>
<td>8.01**</td>
<td>3.65</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.13)</td>
<td>(1.02)</td>
</tr>
</tbody>
</table>

$\text{Durbin-}h$  
1.9208†  
1.5790†

$R^2$  
0.9968  
0.9980

$R^2$  
0.9959  
0.9975

$F_{7,26}$  
1143.6‡  
1874.0‡

* $t_{26}(10\%)=1.706$

** $t_{26}(5\%)=2.056$

† $N(5\%)=1.645$

‡ $F_{7,26}(1\%)=3.46$
excess demand when the market rate was above the natural rate.

As defined in Chapter 3, \( \beta_2 = \beta_{12} - \beta_{22} + \lambda \beta_{32} \), and \( \beta_{12} \) is greater than zero and both \( \beta_{22} \) and \( \beta_{32} \) are less than zero. Since \( \beta_2 \) is significantly different from zero and positive, the combined effect of inflationary expectation on investment and saving will be greater than that on money demand. Higher inflationary expectations tend to widen the gap of demand and supply of loanable capital, given the pegged rate below the natural rate, which requires the Fed to generate greater excess money supply to prevent the rate of interest from rising. Although higher inflationary expectations also decrease people's desire to hold their wealth in the form of money balances, the decline in demand for money balances does not raise the excess money supply to the level which was required to fill the widening gap of excess demand for loanable capital without the Fed's expansionary monetary action.

The income variable is positive and significant. As defined in Table 3.1, \( \beta_3 = \beta_{13} - \beta_{33} + \lambda \beta_{33} \), and investment, saving, and demand for money balances are all positively related to income, the positive estimated \( \beta_3 \) concludes that the combined effect of income on investment and on the demand for money balances was greater than the effect of income on saving. Higher income will increase investment and saving at the same time. If we believe higher income
has a greater impact on investment than that on saving, then higher income will push the natural rate of interest to a higher level. Given the interest pegging commitment, higher income will cause the Fed to increase monetary expansion to raise the level of excess money balances when the effect is to raise the natural rate or reduce the excess money demand when the effect is to lower the natural rate. Even we assume that higher income has the same effect on investment as that on saving, and the natural rate of interest remains unchanged, higher income will raise the demand for money balances and the Fed would have to increase monetary expansion in order to generate the same necessary amount of excess supply or demand for money.

The parameters for the real income growth rate variable are positive and significant. This represents the impact of the growth rate on investment is greater than that on saving.

The estimates for the parameters of the variables federal deficit and net exports are positive. They are all significant except the parameter of federal deficit in M1 equation. The higher the federal deficit and net exports, the higher the demand for loanable capital and therefore the natural rate of interest will increase. Other things remain unchanged, the Fed would have to increase monetary expansion to raise the excess money supply in order to maintain the pegged rate.
From the estimates of $\beta_i$ in both M1 and M2 regression equations, we can calculate the rates of adjustment for two definitions of money. The rate of adjustment, $\lambda$, for M1 definition of money equals 0.13 and that for M2 equals 0.07. The faster rate of adjustment in M1 compared to M2 reflects higher costs in making adjustments in the portfolios dealing with savings and time deposits versus demand deposits and currency. The estimates of the current study tend to lie in the lower end of estimate 0.283 concluded by Goldfeld$^3$ and 0.10 estimated by Cooper, Modigliani, and Rasche.$^4$

Overall, the money supply equations fit reasonably well, even the $R^2$ which takes account of the degrees of freedom cannot refute this conclusion. Since the regression equation has the lagged dependent variable on the right hand side, the Durbin-Watson statistics which detect any serial correlation will not apply. Durbin-h statistics are therefore calculated and compare to the normal statistic of five percent confidence interval 1.645. Durbin-h statistic is less than 1.645 for M2 and not M1. We therefore cannot reject the null hypothesis that there is no first-order


serial correlation in the M2 regression equation. We will look at the Durbin-h statistic very closely when we estimate equation 3.8 and test for structural change. If the same statistic concludes the existence of serial correlation, we will address the concern at that point. The correlation matrices and standard errors of coefficients were examined to suggest no major multicollinearity problem in the regression estimates.

4.2.2 Test for Structural Change

The structural change in the money demand function can be interpreted from the two estimated coefficients $\beta_g$ and $\beta_9$ of equation 3.8 as shown in Table 4.2 where:

$$\beta_g = \Delta \alpha = \Delta \alpha_1 - \Delta \alpha_2 + \Delta \lambda \alpha_3; \text{ and}$$

$$\beta_9 = \Delta \beta_1 = \Delta \beta_{11} - \Delta \beta_{21} + \Delta \lambda \beta_{31}.$$  

There were no major incidents during the period of study to suggest any structural changes in investment and saving functions, therefore we can assume:

$$\Delta \alpha_1 = \Delta \alpha_2 = 0, \text{ and } \beta_g = \Delta \alpha = \Delta \lambda \alpha_3; \text{ and}$$

$$\Delta \beta_{11} = \Delta \beta_{21} = 0, \text{ and } \beta_9 = \Delta \beta_1 = \Delta \lambda \beta_{31}.$$  

The estimates of $\beta_g$ are negative and significant in both M1 and M2 money supply equations. The estimates of $\beta_9$ also are positive and significant in both M1 and M2 money supply equations. The Chow Test allows us to reject the null hypothesis and conclude that $\beta_g$ and $\beta_9$ are jointly

---

$^5$ see Appendices, Table A.2, p. 83.
TABLE 4.2: TEST FOR STRUCTURAL CHANGE

Dependent Variables
(Equation: 3.8)

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Parameters</th>
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<th>M2</th>
</tr>
</thead>
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<td>-6.09**</td>
</tr>
<tr>
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<td>(-4.44)</td>
<td>(-3.76)</td>
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<td>$\pi^*$</td>
<td>$\beta_2$</td>
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<td>0.27**</td>
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<tr>
<td></td>
<td></td>
<td>(2.09)</td>
<td>(2.21)</td>
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<tr>
<td>$Y$</td>
<td>$\beta_3$</td>
<td>0.04**</td>
<td>0.03**</td>
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<td></td>
<td></td>
<td>(3.63)</td>
<td>(2.49)</td>
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<td>$g$</td>
<td>$\beta_4$</td>
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<td></td>
<td>(2.09)</td>
<td>(2.02)</td>
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<td>0.006</td>
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<tr>
<td></td>
<td></td>
<td>(0.29)</td>
<td>(1.01)</td>
</tr>
<tr>
<td>NX</td>
<td>$\beta_6$</td>
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<td>0.19**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.19)</td>
<td>(2.80)</td>
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<tr>
<td>$M_{t-1}$</td>
<td>$\beta_7$</td>
<td>0.86**</td>
<td>0.94**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(19.4)</td>
<td>(29.2)</td>
</tr>
<tr>
<td>D</td>
<td>$\beta_8$</td>
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<td>-11.5*</td>
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<td></td>
<td></td>
<td>(-3.15)</td>
<td>(-2.52)</td>
</tr>
<tr>
<td>Di</td>
<td>$\beta_9$</td>
<td>4.97**</td>
<td>4.97*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.36)</td>
<td>(2.78)</td>
</tr>
<tr>
<td>CONSTANT</td>
<td>$\alpha$</td>
<td>18.1**</td>
<td>13.8**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(4.22)</td>
<td>(3.00)</td>
</tr>
<tr>
<td>Durbin-h</td>
<td></td>
<td>-0.3556‡</td>
<td>-0.2885†</td>
</tr>
<tr>
<td>$R^2$</td>
<td></td>
<td>0.9979</td>
<td>0.9986</td>
</tr>
<tr>
<td>$R^2$</td>
<td></td>
<td>0.9971</td>
<td>0.9980</td>
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<tr>
<td>$F_{9,24}$</td>
<td></td>
<td>1245.2‡</td>
<td>1867.3‡</td>
</tr>
</tbody>
</table>

Chow Test; $F_{2,24}(5%)=3.40  6.18  4.64$

$t_{24}(10%)=1.711  \quad t_{24}(5%)=2.046$;

$N(5%)=-1.645;  \quad F_{9,24}(1%)=3.26$. 

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significant. The Durbin h statistics indicate no first-order serial correlation in both M1 and M2 regression equations. We can therefore estimate the change in the money demand function using the estimates of $\beta_1$ and $\beta_3$. Table 4.3 summarizes the estimates of the structural change in the money demand function.

### Table 4.3 Estimates of Structural Change in Money Demand

<table>
<thead>
<tr>
<th></th>
<th>M1</th>
<th>M2</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_8 = \hat{\Delta} \lambda \alpha_3$</td>
<td>-11.8</td>
<td>-11.5</td>
</tr>
<tr>
<td>$\beta_9 = \hat{\Delta} \lambda \beta_3$</td>
<td>4.97</td>
<td>4.97</td>
</tr>
<tr>
<td>$\Delta M^d = \hat{\beta}_8 + \hat{\beta}_9 \bar{y}$</td>
<td>1.62</td>
<td>1.92</td>
</tr>
<tr>
<td>$\text{Var}(\Delta M^d)^6$</td>
<td>0.4648$^\dagger$</td>
<td>0.7206$^\ddagger$</td>
</tr>
<tr>
<td>$\sigma_{\Delta M}$</td>
<td>0.6818</td>
<td>0.8489</td>
</tr>
</tbody>
</table>

$^\dagger$ $(1)^2(13.994) + (2.7)^2(2.190) + 2(1)(2.7)(-5.4619) = 0.46484$

$^\ddagger$ $(1)^2(20.699) + (2.7)^2(3.196) + 2(1)(2.7)(-8.0143) = 0.72062$

$\hat{\beta}_8$ is equal to $\hat{\Delta} \lambda \alpha_3$, which is the estimated change in the constant term of the money demand function while $\hat{\beta}_9$ is equal to $\hat{\Delta} \lambda \beta_3$, which is the estimated change in the first derivative of money demand with respect to interest rate.

---

$^6$ According to Kmenta (1986) p. 486, the variance of the change in money demand, $\text{Var}(\Delta M^d)$, can be estimated by the following equation:

$$(\partial f/\partial \beta_8)^2 \text{Var} \beta_8 + (\partial f/\partial \beta_9)^2 \text{Var} \beta_9 + 2(\partial f/\partial \beta_8)(\partial f/\partial \beta_9) \text{Cov}(\beta_8, \beta_9)$$
The change in the quantity demanded for money, $\Delta M^d$, therefore equals the sum of the change in the constant term, $\beta_1$, and the change in the coefficient of the interest rate variable times the average of the long-term interest yield after the Accord, $\beta_2 \bar{I}$, where $\bar{I}$ equals 2.70.

There is an increase in the quantity of money demanded derived from M1 and M2 equations, 1.62 and 1.92 respectively. The estimated standard errors of $\Delta M^d$ for the two equations are 0.6818 and 0.8489 respectively which indicate that both coefficients are significant.

The above result suggests the Accord which increased the interest rate volatility and the risk of holding bonds had increased the quantity demanded for money. The increase in the coefficient of the interest rate variable implies a decrease in interest elasticity of money demand. After the Accord, people were less responsive to the change in interest rate. In other words, it would require a greater percentage change in interest rate to produce the same percentage change in quantity demanded for money. We can therefore conclude that the demand for money increased and the interest elasticity of money demand decreased after the Accord.
CHAPTER 5
CONCLUSION

As we observe only the money supply and not the money demand, money demand cannot be explicitly estimated given disequilibrium in the money market during the price-pegging era. Money supply is endogenously determined by all economic variables which determine the disequilibrium in the money market necessary to produce the pegged rate. Money supply is determined by investment, saving, federal deficits, taxes, net exports, money demand, and whatever determine them. The model explains the money supply from the first quarter of 1947 to the second quarter of 1955 very well. After the Accord, the intercept fell along with a drastic decline in the interest elasticity of money demand as indicated by the empirical results. By abandoning the interest-pegging policy, higher interest volatility has increased the risk of holding bonds. The overall increase in money demand which was observed following the Accord had been caused by the significant fall in the interest elasticity of money demand. If we ignore the disequilibrium in the money market and try to produce an explicit estimate of the money demand for the period, we will be measuring the money supply instead of the money demand with an identification problem. If we ignore the consequence of the Treasury-Federal Reserve Accord and use one single function
to represent the money demand for the whole period, we will
under-estimate the interest elasticity of money demand
before the Accord and over-estimate the interest elasticity
of money demand after the Accord.
## APPENDICES

### TABLE A.1 EMPIRICAL DATA - QUARTERLY OBSERVATIONS

(1947.1 TO 1955.2)

<table>
<thead>
<tr>
<th>YEAR.Q</th>
<th>M1</th>
<th>M2</th>
<th>i</th>
<th>( \pi^e )</th>
<th>Y</th>
<th>g</th>
<th>FD</th>
<th>NX</th>
</tr>
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<tr>
<td></td>
<td>($b$)</td>
<td>($b$)</td>
<td>(%)</td>
<td>(%)</td>
<td>($b$)</td>
<td>(%)</td>
<td>($b$)</td>
<td>($b$)</td>
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<td>2.24</td>
<td>2.45</td>
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<td>12.9</td>
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**TABLE A.2  CORRELATION MATRICES OF VARIABLES (EQUATION 3.7)**

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<th>i</th>
<th>(\pi^e)</th>
<th>Y</th>
<th>g</th>
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<th>NX</th>
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