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AN EMPIRICAL ANALYSIS OF THE DETERMINANTS OF THE

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AN INSTITUTIONAL APPROACH

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AN EMPIRICAL ANALYSIS OF THE DETERMINANTS OF THE UNITED STATES TREASURY BILL RATE, 1953-1964: AN INSTITUTIONAL APPROACH

CHAPTER I

INTRODUCTION

This study is concerned with the factors determining the United States Treasury bill rate during the period 1953-1964. The approach is a partial-equilibrium, comparative-static demand analysis of the existing stock of Treasury bills over monthly time periods. A basic premise underlying this study is that it is interesting and meaningful to analyze the determinants of the interest rate of a single asset.

Portfolio holdings of Treasury bills by commercial banks, non-financial corporations, state and local governments, foreign governments and banks, Government securities dealers, and others are viewed as the demand for an asset having unique properties and good, though imperfect, substitutes in the form of money or other interest bearing assets. The stock of Treasury bills available for these institutional sectors to hold is determined principally by Treasury debt management decisions and Federal Reserve System open market operations. The Treasury bill rate is considered to be a price of a commodity that is determined by demand and supply forces operating through the market mechanism. The approach, therefore, is partial-equilibrium, and represents an attempt to measure bill rate changes as determined by the direct market variables instead of the general-equilibrium approach which emphasizes the supply of and demand for "money."

In the simplest form, the Keynesian liquidity preference approach to interest rate determination concludes that "<u>the</u> interest rate" will be reduced by an increase in the stock of money or a decrease in the demand to hold the stock (a shift in the liquidity preference schedule to the left). It has subsequently been shown by Turvey,[1] Brechling,[2] and Kragh[3] that the simple liquidity preference schedule, as normally shown, is valid only if the quantity of bonds remains constant. The liquidity preference schedule showing the quantity of money which would be held at various rates of interest is simply the "mirror image" of the stock of securities desired at various rates. The rate of interest depends upon both the stock of money and the stock of assets.[4] Holding the stock of

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[1]Ralph Turvey, <u>Interest Rates and Asset Prices</u> (London: George Allen and Unwin, Ltd., 1960), pp. 19-26.

[2]Frank P. R. Brechling, "A Note on Bond-Holding and the Liquidity Preference Theory of Interest," <u>Review of Economic Studies</u>, Vol. XXIV, No. 6 (June, 1957), pp. 190-197.

[3]Börje Kragh, "The Meaning and Use of the Liquidity Curves in Keynesian Interest Theory," <u>International Economic Papers</u>, No. 5, 1955, pp. 155-169.

[4]"...the elementary post-Keynesian approach...shows what is involved when attention is shifted from the demand for money to the determination of interest rates. If we reserve the demand function for money, we deduce that, <u>ceteris paribus</u>, a change in the quantity of money will alter interest rates. But there are also demand functions for short-term and long-term paper. By the same token, therefore, a change in the quantities of these assets will also alter interest rates. Thus knowledge of the demand function for money, though necessary, is not sufficient to explain interest rates." Ralph Turvey, "On the Demand for Money," <u>Econometrica</u>, Vol. 33, No. 2 (April, 1965), p. 460.

money constant, a change in the quantity of assets therefore would cause the rate of interest to change. One of the principal purposes of this study is to measure the effect on the bill rate of changes in the quantity of Treasury bills.

The effect of the quantity of bills on the bill rate is also related to rival hypotheses of the determination of the term structure of interest rates. Term structure hypotheses could be placed on a spectrum between the extremes of the "expectational" hypothesis and the "institutional" hypothesis. In the purest form the expectational hypothesis asserts that assets differing only in maturity dates are perfectly substitutable and that a long-term rate depends on an average of future short-term rates.[5] The relative quantities of assets in each maturity category are not assumed to affect relative interest rates.

At the other extreme the institutional hypothesis places emphasis on the segmentation of the market through institutional demand for specific maturities and the relative quantities of these securities available to be held.[6] Although this is a study of the level of a single rate as opposed to relative rates of different maturities, it is evident that the general approach is nearer the institutional than the expectational end of the spectrum.

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[5]Examples of hypotheses near the "purely expectational" hypothesis are: Frederick A. Lutz, "The Structure of Interest Rates," reprinted in the American Economic Association Readings in the Theory of Income Distribution, Edited by William Fellner and Bernard F. Haley (Philadelphia: The Blakiston Company, 1951), pp. 499-529; and David Meiselman, The Term Structure of Interest Rates (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1962).

[6]Examples of the general approach of the institutional hypothesis may be found in J. M. Culbertson, "The Term Structure of Interest Rates," The Quarterly Journal of Economics, LXXI, No. 4 (November, 1959), pp. 485-517; and Joseph Conard, An Introduction to the Theory of Interest (Berkeley: University of California Press, 1959), pp. 304, 325, 330-339.

This examination of the determinants of the Treasury bill rate has debt management and monetary policy implications. An attempt is made to measure the effect on the bill rate of a Treasury debt management or a Federal Reserve System open market transaction. The time period of the analysis begins after the Treasury-Federal Reserve System Statement of Accord as the maintenance of the wartime rate structure on Federal marketable securities was relaxed, and interest rates on these securities were permitted to fluctuate through supply and demand forces in the open market. This does not imply, however, that the bill rate (or any other Treasury interest rate) has been completely removed from the potential or partial control of the Treasury and the Federal Reserve System. Tobin states that:

> "Interest rates are already under government control. The market that determines them does so under the watchful eyes of the monetary authorities, and in an environment of their making. If the Federal Reserve and Treasury do not like the market's results they can and do intervene to change them."[7]

Since the Statement of Accord the Federal Reserve System has not dominated the market for Federal marketable securities as was true of the pegging policy which existed throughout the war years and the early post-war years. Since the accord the principal target variable for open market operations has been member bank reserves. From 1952 through 1960 most System open market operations were carried out in Treasury bills, and

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[7]James Tobin, "An Essay on Principles of Debt Management," Fiscal and Debt Management Policies (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1963), p. 187. Similarly, William Fellner has pointed out that: "...central banks will presumably not be willing to let the prices of government securities fall and fluctuate to such an extent that the market for these securities would scare away conservative buyers when the treasury engages in refinancing operations." Felner, Trends and Cycles in Economic Activity (New York: Holt, Rinehart and Winston, 1956), p. 371.

although transactions affect the bill rate, the effect occurs indirectly through the market mechanism instead of being directly regulated as the target variable. A purpose of this study is to attempt to measure the effect of open market bill transactions on the bill rate.

The "bills only" policy of the Federal Reserve System was discontinued in February, 1961, as the System began executing open market transactions in longer maturities under the joint attempt by the Treasury and the System to raise the level of short-term rates absolutely, relative to long-term rates, and relative to the short-term rates in other countries.[8] The new policy, still in effect, gives higher priority to the interest rate as a target variable. The purpose of this operation ("twist" or "nudge") has been to induce foreign governments and banks, and indeed, domestic asset holders, to hold United States Treasury debt instruments. In order to raise short-term rates the Treasury has greatly increased the quantity of bills relative to other maturities and the System has carried out a portion of its open market operations in maturities other than bills.

Precise estimation of the effects of these policies on the bill rate is complex. For instance, an open market transaction by the Federal Reserve System affects both the demand for bills and the stock of bills available to be held. The stock of bills is directly affected by a transaction, whereas the demand for bills is affected indirectly with time lags, as credit conditions and the money supply change as commercial banks adjust to new reserve positions.

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[8] For comments relating the apparent success of this policy to the hypotheses of term structure of rates, see: Harry G. Johnson, "Major Issues in Monetary and Fiscal Policies," Federal Reserve Bulletin, Vol. 50, No. 11 (November, 1964), pp. 1409-1410.

Because of the policy influences on both the demand for and the stock of bills, it is evident that a structural model of simultaneous equations is needed. A step in this direction has recently been taken by Frank deLeeuw as a part of the Brookings Institute-Social Science Research Council quarterly econometric model of the United States.[9] His section of the model deals with financial behavior by institutional sectors in various securities markets. By using quarterly data, deLeeuw is able to relate equations of supply and demand for securities to the overall macroeconomic model.

Since significant movements of the short-term rate occur over time periods shorter than a quarter of a year, an adequate explanation of rate movements would require analysis over shorter time periods. In this study, significant monthly and weekly seasonal movements in the bill rate have been measured, indicating that an appropriate time period for successive observations would be less than quarterly. However, weekly observations are unavailable for many relevant independent variables; and although a great deal of applicable monthly data are available for the complete period, this eliminates the possibility of relating to a macroeconomic model since the shortest period for most aggregative data is quarterly. Monthly periods have been chosen as an appropriate time interval and the empirical estimates of bill rate relationships have been calculated by single-equation regression methods. However, there are pitfalls in utilizing time intervals as short as a month in multiple regression equations. One of the most important problems has been pointed out by Stefan Valavanis:

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[9] Frank deLeeuw, "A Model of Financial Behavior," The Brookings-SSRC Quarterly Econometric Model of the United States (Chicago: Rand McNally & Company, 1965), Chapter 13.

> As the time interval is shortened, more and more variables change from predetermined to simultaneously determined. With shorter and shorter time periods, the causes that generate the random terms overlap more and more and invalidate the assumption of serially independent random disturbances.[10]

This problem of positive autocorrelation of residuals is the most perplexing statistical problem in the whole study. Estimation difficulties were also encountered in attempting to measure seasonal movements in the bill rate. The simple moving-average methods of seasonal measurement yielded biased results because of the great volatility in the bill rate during 1958-1959. The more sophisticated X-10 Version of Census Method II, however, appears to provide meaningful estimates.

Some difficult problems have been encountered in collecting appropriate statistical data for this study. In some cases data are available only for a small portion of the time period 1953-1964, and in other cases data are not available at all. Some of the monthly series are very accurate, whereas other series are provided on a sample basis and are subject to a large, unspecifiable error. Some data are in terms of "average for the month," and some data are in terms of the "level at the end of the month." In all cases these data are described in detail, and an attempt has been made to indicate in a qualitative manner the degree of their reliability. The use of digital computers with truncation after eight digits further complicates the accuracy of calculated results, especially in the multiple regression estimates.[11] Therefore, the final empirical

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[10] Stefan Valavanis, Econometrics (New York: McGraw-Hill Book Company, 1959), p. 167. The same warning is found in: Lawrence R. Klein, A Textbook of Econometrics (Evanston, Ill.: Row, Peterson and Company, 1953), pp. 313-322.

[11] For a discussion of truncation errors, as well as other data and specification problems mentioned here, see: Oskar Morgenstern, On the Accuracy of Economic Observations (2nd Edition, Princeton: Princeton University Press, 1963).

results should be interpreted as estimates which may be subject to rather large errors.

This study may be viewed as having three principal parts: descriptive, theoretical, and empirical. Although these divisions are not clear-cut, they assist in explaining the general outline.

The first part is primarily descriptive. Chapter II covers the development of the Treasury bill market and outlines the operation of the market, describing the principal market participants. Chapter III describes the movements of the bill rate over the period 1953-1964, and attempts to measure the trend, seasonal, cyclical, and irregular movements. Chapter IV contains a discussion of the relationship of the Treasury bill rate with other interest rates and attempts to measure the degree of association through simple linear regression.

The second part deals with the theoretical framework and a discussion of relevant independent variables. Chapter V consists of the definition and specification of the simple theoretical structures. Treasury debt management, Federal Reserve operations and the expected effect on the bill rate are examined more closely in Chapter VI.

The third part is mostly empirical, and builds upon the framework of the second part. In Chapter VII the relationships between the bill rate and the bill stock are estimated and the results interpreted. In Chapter VIII the relationship between the bill rate and bill holdings by institutional sectors is examined. Chapter IX provides a summary and reviews conclusions.

CHAPTER II

A DESCRIPTION OF THE TREASURY BILL MARKET AND THE PRINCIPAL PARTICIPANTS

Introduction

The Treasury bill first came into use in Great Britain with the Treasury Bill Act of 1877.[12] The 90-day Treasury bill replaced the Exchequer bill,[13] a five year maturity instrument, to provide greater flexibility to the Chancellor of the Exchequer in raising short-term funds.

The Treasury Bill Act of 1877 limited the maturity of the bill to one year or less. The act allowed the Treasury to regulate the form of the bill, the interest rate, and the conditions of issue, but the actual

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[12] Sir Herbert Brittain, The British Budgetary System (London: Allen and Unwin, 1959), p. 194. The Treasury bill was the idea of Walter Bagehot in 1876. Sir Stafford Northcote (Disraeli's Chancellor) had asked Bagehot for advice when it became apparent that the old Exchequer bill was inadequate for raising the needed short-term funds. The Treasury bill, having the characteristics of the commercial bill of credit plus the backing of the Government, was Bagehot's solution to the problem. For a brief history of the Treasury bill in England, see: "The Treasury Bill: The Story of an Economists Invention," Midland Bank Review, February, 1961, pp. 39.

[13] The history of the Exchequer bill is described in R. D. Richards, "The Exchequer Bill in the History of English Government Finance," Economic History: A Supplement to the Economic Journal, III (1934-1937), 1937, pp. 193-211.

issue of the bills was the responsibility of the Bank of England.[14] Since the beginning of their issue, Treasury bills have been in continuous use in England.

The use of the Treasury bill in the United States is a relatively recent development. The United States Treasury was authorized to issue Treasury bills on June 17, 1929.[15] The first issue was a 91-day maturity, dated December 17, 1929, to mature on March 17, 1930. The quantity of bills sold in that first issue totaled $100 million.[16]

The American version of the Treasury bill and the method of its sale were closely modeled after the British system. As with the British bill, the terms of sale were prescribed by the Treasury (in Treasury Department Circular Number 418),[17] with the invitation for tenders adding any further conditions or information for a particular sale. Also, as was the case with the British bill, the tenders were submitted to the central bank. In the United States the Federal Reserve Banks received payment from buyers and made the actual issue of the bills at the direction of the Treasury. The technique of the sealed-bid auction and the selling of bills at a discount instead of specifying an interest rate were other major similarities.

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[14] Brittain, op. cit., p. 194.

[15] Annual Report of the Secretary of the Treasury on the State of the Finances for the Fiscal Year Ended June 30, 1929, pp. 38, 273-279. The specific authorization for the issue of Treasury bills was H. R. 1648, an amendment to the Second Liberty Bond Act. The amendment was introduced by Senator Smoot and Representative Hawley.

[16] Annual Report of the Secretary of the Treasury on the State of the Finances for the Fiscal Year Ended June 30, 1930, pp. 38, 285-287.

[17] This Circular was dated November 22, 1929. With amendments, it is presently the basic regulation prescribing conditions of sale for the Treasury bill.

It was apparent, though, that the United States Treasury did not plan to issue bills on as large a scale as the British. From early statements of Treasury officials, it seems that the use of Treasury bills was planned to be rather limited, basically to supplement Certificates of Indebtedness in short-term finance. The bill was originally intended to meet those seasonal cash needs of the Treasury caused by temporary imbalances of receipts and expenditures prior to tax dates.[18]

Although the principal function of the Treasury bill in the first decade of use was in meeting seasonal needs, a small portion of the debt was being "rolled over"[19] regularly in the form of bills. At the end of December, 1941, approximately $2 billion of the Federal debt was in the form of Treasury bills.[20]

By the end of World War II, the quantity of Treasury bills outstanding totaled $17 billion. This large increase in the quantity of bills was a result of the rapid rise in the total Federal debt in the war period. During the war, minimization of the interest cost of the increasing debt was one of the principal goals of the Treasury. The Federal Reserve System maintained ("pegged") the Treasury bill rate at a level of 0.375 per cent. Since the Federal Reserve bought and sold bills in the market when the rate tended to deviate from the pegged rate, the Treasury bill was completely liquid. The low interest rate on bills (other Federal

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[18] Annual Report of the Secretary of the Treasury, 1929, op. cit., pp. 275-279.

[19] Replaced at maturity by identical securities.

[20] In the following discussion, Treasury bill is used as meaning United States Treasury bill. Every major Western European country and Canada has a short-term debt instrument called a "Treasury bill;" however, these bills do not have identical properties.

securities were pegged less rigidly at a higher rate) induced the Treasury to finance the deficit in part through the use of the bill.

By the end of December, 1952, $21.7 billion in bills were outstanding, representing 14.6 per cent of total marketable Federal debt outstanding (8.2 per cent of the total Federal debt). By December 31, 1956, the quantity of bills outstanding had increased to $25.2 billion, representing 15.4 per cent of total marketable debt. By December 31, 1964, bills outstanding totaled $56.5 billion, which constituted 26.6 per cent of the total marketable debt, and 63.8 per cent of the marketable debt within one year to maturity.[21]

The Treasury bill has become one of the most important marketable securities issued by the Treasury. It has largely replaced the Certificate of Indebtedness, and, since the introduction and routine issue of longer-term bills, the use of tax-anticipation bills, and the experimental use of "strip" issues of bills,[22] this instrument has gained greater flexibility in its use by the Treasury. Also, because of their high degree of liquidity, bills are being demanded by more types of investors and in greater quantities.

The development of the Treasury bill market has progressed rapidly since the end of World War II. However, the behavior of the different investor groups has been rather unstable, with some rapidly increasing their holdings of bills, while others have been gradually decreasing their holdings. Since the development of the Government securities market, the mechanics of the market, and the behavior of the principal investor groups

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[21] Treasury Bulletin, various issues.

[22] These issues are described in greater detail in latter portions of this Chapter.

are important to an analysis of the Treasury bill market, this portion of the study attempts to describe the market in some detail. The emphasis will be on the following: (1) the Treasury bill itself; (2) the primary and secondary markets, with emphasis on market mechanics; (3) the operations of the Federal Reserve System and its role in the market; and (4) the magnitude of holdings and the relative importance of the different investor groups in this market.

Description of the Treasury Bill

The Treasury bill is the shortest term obligation issued by the United States Treasury in the financing of the Federal debt. The Treasury bill differs from other Federal government debt instruments in maturity, method of sale, and interest rate.

The Treasury bill has a maturity not exceeding one year. In the period covered in this study, 1953-1964, 91-day bills were the only regularly issued bill maturities until December 11, 1959, when the Treasury added a six-month bill to its regular weekly issue. Also, in 1960, nine-month and one-year bills began to be regularly marketed.

Bills are sold by the Treasury through the auction technique. Those desiring to obtain bills in the weekly auction submit sealed bids to their district Federal Reserve Banks which forward the price and quantity information to the Treasury. The Treasury arrays the bid prices from high to low and aggregates the volume bid for at each price. Then, beginning with the highest bid price and moving toward lower prices, tenders are accepted until the cumulative volume is equal to the amount offered for the particular weekly tender. For each quantity accepted, the successful bidder pays the price bid, while bids below that price at which the Treasury has been able to meet the required volume are disregarded.

The Treasury bill does not yield a fixed interest rate. Successful bidders pay a price that is less than the maturity value of the bill. The discount, the difference between the price paid and the maturity value, is considered the interest payment. A high price corresponds to a low interest yield; conversely, the lower the price, the higher the yield. Prices are quoted on the basis of the amount paid for $100 maturity value. For example, a price of $99.00 for a 91-day bill would be equivalent to a yield of 3.96 per cent if the bill were held to maturity. The interest rate on bills is conventionally computed and quoted on a "bank discount" basis. In the above example, the computation of the discount rate requires dividing the amount of the discount by the number of days to maturity as a percentage of 360.[23] On the other hand, the interest rate on most other United States government securities is quoted on the basis of a coupon, and thus the rates are not necessarily comparable to the rate of discount on bills. For the same maturity and amount invested, the discount rate will be lower than the corresponding coupon rate. The difference arises because, (a) the discount rate is computed on the maturity value instead of the price paid, (b) the number of days to maturity is related to 360 days instead of 365, and (c) the coupon rate assumes semi-annual compounding if more than one coupon period (six months) is involved. The first two of these dissimilarities tend to lower the discount rate

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[23] In the example above, the computation would be:

$$\frac{100-99}{100} \cdot \frac{360}{91} \cdot 100 = 3.956.$$

The "true discount" rate equals:

$$\frac{100-99}{99} \cdot \frac{365}{91} \cdot 100 = 4.052.$$

See: Ira O. Scott, Jr., Government Securities Market (New York: McGraw-Hill Book Co., 1965), pp. 45-46; and, Henry N. Goldstein, "Should the Treasury Auction Long-Term Securities?," The Journal of Finance, XVII, No. 3 (Sept., 1962), p. 450.

relative to the coupon rate and the last dissimilarity causes a relative rise. The upward influence is not relevant with three-month periods. For periods of over six months, however, this influence is less than the downward effect caused by (a) and (b) above.[24]

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[24]Goldstein, op. cit., p. 450, shows that calculating the coupon equivalent yield (i) for a bill having exactly one year to maturity yields:

$$i = 2\left[\left(\frac{100}{P}\right)^{1/2} - 1\right];$$

and generally, for a bill having more than six months to maturity:

$$P\left[1 + \frac{i}{2}\right]\left[1 + \frac{i}{2}\left(\frac{t-182.5}{182.5}\right)\right] = 100,$$

where P is price and t is days to maturity. This is, of course, before tax yield. Tax information regarding Treasury bills is provided by the Treasury Department and included on the tenders issued by the Federal Reserve Banks. The tender from the Dallas Federal Reserve Bank for December 21, 1961 quotes from the Treasury statement:

> "The income derived from Treasury bills, whether interest or gain from the sale or other disposition of the bills, does not have any exemption, as such, and loss from the sale or other disposition of Treasury bills does not have any special treatment, as such, under the Internal Revenue Code of 1954. The bills are subject to estate, inheritance, gift or other excise taxes, whether Federal or State, but are exempt from all taxation now or hereafter imposed on the principal or interest thereof by any State, or any of the possessions of the United States, or by any local taxing authority. For purposes of taxation the amount of discount at which Treasury bills are originally sold by the United States is considered to be interest. Under Sections 454 (b) and 1221 (5) of the Internal Revenue Code of 1954 the amount of discount at which bills issued hereunder are sold is not considered to accrue until such bills are excluded from consideration as capital assets. Accordingly, the owner of Treasury bills (other than life insurance companies) issued hereunder need include in his income tax return only the difference between the price paid for such bills, whether on original issue or on subsequent purchase, and the amount actually received either upon sale or redemption at maturity during the taxable year for which the return is made, as ordinary gain or loss."

Although interest on coupon issues is similarly treated, the opportunity for capital gain rates would apply if the coupon security were sold prior to maturity. Also, see: William L. Raby, The Income Tax and Business Decisions (Englewood Cliffs, N. J.: Prentice-Hall Inc., 1964), pp. 144 and 293-294.

Treasury bills are not restricted as to ownership, and are highly marketable. The short maturity and the high degree of marketability combine to make the bill extremely liquid. If held the short period of time to maturity, the bill becomes money. In addition, a highly organized market exists making it possible to sell bills at any time at the market price.

Due to their liquidity, bills provide an ideal form for the holding of transactions, precautionary, or speculative balances. Temporary unused cash is turned into an interest bearing asset that can be liquidated almost immediately when needed. Treasury bills are widely held by many investors of short-term funds. Tilford C. Gaines has described Treasury bills as "beyond question the most widely held and most popular income-earning liquidity instrument in the United States money market."[25] Bills are held by commercial banks, insurance companies, nonfinancial corporations, foreign governments and banks, state and local governments, pension and trust funds, agencies of the Federal government, and individuals. Government securities dealers maintain an inventory of bills that is quite sizeable. Also, the Federal Reserve Open Market Account is a large holder of Treasury bills, and has traded bills almost exclusively in the open market in the exercise of monetary policy. The popularity of the bill and its wide ownership make it the most actively traded Government security.

Individuals and institutions desiring Treasury bills may purchase them directly from the Treasury, or purchase outstanding bills in the open market. Direct Treasury sales to bidders in the weekly auction are

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[25] Tilford C. Gaines, Techniques of Treasury Debt Management. (New York: The Free Press of Glencoe, 1962), p. 177.

considered the primary market for Treasury bills; buying and selling bills in the over-the-counter government securities market is considered the secondary market for bills. The mechanics of these markets for United States Treasury bills will be explained in greater detail.

The Mechanics of the Primary Market

The primary market for Treasury bills involves the direct Treasury sale through the weekly auction. Each week the Treasury markets an issue of 91-day bills and a companion issue of six-month (182-day) bills.[26] Usually the quantity sold by the Treasury for a particular week will be an amount just large enough to replace the issues that are maturing in that particular week. When the Treasury desires to raise new funds over a period of time, the new issues will be increased in volume each week over the complete cycle of bills. This requires 13 weeks for the 91-day bills, and six-months for the longer bills. At the end of 26 weeks, the quantities of bills sold each week would again be equalized. The nine-month, one-year, and tax-anticipation bills are used primarily for the purpose of raising additional funds for the purpose of meeting the more seasonal needs of the Treasury.[27] The bulk of the volume of Treasury bills is considered permanent short-term debt and is replaced weekly on maturing.

In June, 1961, a novel method of increasing the quantity of outstanding bills was accomplished by the Treasury. It involved a special

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[26] Prior to December, 1959, a single issue of 91-day bills was marketed weekly.

[27] Tax anticipation issues can be either in the form of Certificates of Indebtedness or bills. If they are issued with a maturity of less than one year, bear a discount rate, and are sold through sealed bids, they are considered bills. See: Gaines, op. cit., p. 181.

tender for $1.8 billion, made up of 18 different maturities of $100 million each. The maturities were matched to the maturities of 18 outstanding issues of bills whose times to maturity were spaced one week apart from a minimum of 50 days to a maximum of 169 days. Subscriptions were required in even multiples of $18,000 from bidders, with successful bidders receiving an equal allotment of each of the 18 different maturities.[28]

This method of increasing the quantity of bills outstanding, referred to as a "strip" issue, has been used several times since 1961. In October, 1963, for instance, an additional $1.0 billion of bills was issued, covering 10 different bill maturities ranging from 101 to 164 days.[29]

Unless the date conflicts with a holiday, the announcement of a forthcoming sale of issues of bills is made on a Thursday, a week in advance of the date of issue. Subscriptions are accepted until 1:30 P.M. (EST) on the Monday preceding the issue. The bids are tendered to the Federal Reserve Bank, or the Branch Bank, in the bidder's district.

The individual bidder may submit a competitive or a noncompetitive bid. Competitive bids must list the price that a bidder is willing to pay for a desired quantity of bills. The bid price is based on a $100 maturity value, and is stated to three decimal places. For example, a bid price might be $99.191, which would represent a discount rate of 3.20 per cent per annum. The competitive bidder may enter as many competitive bids as he desires, simply listing the prices he is willing to pay and the

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[28] Annual Report of the Secretary of the Treasury on the State of the Finances for the Fiscal Year Ended June 30, 1961, pp. 91 and 260-262.

[29] Annual Report of the Secretary of the Treasury on the State of the Finances for the Fiscal Year Ended June 30, 1964, pp. 190-191, and 197.

quantities desired at each price. On the other hand, a price is not specified in a noncompetitive bid. A noncompetitive bidder is assured of having his bid accepted in full at a price determined by the accepted competitive bids.

Immediately after opening the bids, the Federal Reserve Banks list the prices of the bids and the quantity bid for at each price and forward the information over leased wires to the Treasury. The Treasury consolidates the information from the twelve Federal Reserve Banks and begins the determination of which bids it will accept and which it will reject.

First, all noncompetitive bids are filled in full at the price to be determined, as shown below, by the mean price of accepted bids. The difference between the amount that the Treasury offers and the total quantity of noncompetitive bids is then filled from the competitive bids. The Treasury fills the competitive bids in full for the highest bidders, moving down the array of prices until the cumulative quantity, including the noncompetitive bids, is approximately equal to the allotment. Once the low acceptable bid is determined, all bids below this price are rejected. Typically the bids at the low price are not accepted in full. The Treasury determines a percentage of those bids at the "stop-out" price that will provide a total quantity approximately equal to the volume previously announced. Each individual bidder at the "stop-out" price receives approximately the same percentage allotment. Since the bills are issued in even denominations of $1,000 this seldom equals the exact amount the Treasury had intended to offer.

The price of the noncompetitive bids is determined by computing the weighted arithmetic mean of the accepted competitive bids. The volume of noncompetitive bids from any individual bidder is presently limited to $200,000 maturity value for 91-day bills, and $100,000 maturity value for the six-month bills.

A competitive bid is entered each week for the Federal Reserve Open Market Account. The bid is rejected if it is below the "stop-out" price. If the bid is high enough to be accepted, the bid price is paid. The Federal Reserve Open Market Account only enters bids to replace those bills that are maturing. Federal Reserve holdings can be reduced by submitting a tender at such a low price that it is sure to be rejected, thereby allowing this issue of bills to "run-off." If the Open Market Account wishes to add to their holding of bills, they must buy them in the open market.[30] Payment to the Treasury is made only in maturing issues, therefore limiting the Federal Reserve Open Market Account to a quantity in the weekly auction no larger than is required to replace maturing bills.

The announcement of the acceptance and rejection of tenders is made by the Treasury on the Tuesday morning following the close of the bidding on Monday afternoon. The Treasury's press release for an allotment of 91-day bills for Tuesday, June 25, 1957, provides an illustration.

> The Treasury Department announced last evening that the tenders for $1,600,000,000 or thereabouts, of 91-day Treasury bills to be dated June 27 and to mature September 26, 1957, which were offered on June 20, were opened at the Federal Reserve Banks on June 24.
>
> The details of this issue are as follows:
>
> Total applied for - $2,515,157,000
>
> Total accepted - $1,602,304,000 (includes $402,862,000 entered on a noncompetitive basis and accepted in full at the average price shown below)[31]

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[30] Gaines, _op. cit._, p. 177.

[31] Treasury Department press release, A. M. Newspapers, Tuesday, June 25, 1957, Washington, D. C.

	Price	Approximate equivalent discount rate
High	99.188	3.212%
Low	99.181	3.240%
Average	99.183	3.231%

(78 per cent of the amount bid for at the low price was accepted.)

Federal Reserve District	Total Applied for	Total Accepted
Boston	$ 52,765,000	$ 39,550,000
New York	1,702,825,000	956,982,000
Philadelphia	37,932,000	21,376,000
Cleveland	78,468,000	71,268,000
Richmond	34,930,000	33,984,000
Atlanta	41,647,000	37,181,000
Chicago	296,315,000	222,335,000
St. Louis	33,974,000	33,374,000
Minneapolis	16,587,000	14,511,000
Kansas City	53,659,000	43,442,000
Dallas	43,553,000	33,213,000
San Francisco	122,502,000	95,108,000
TOTAL	$ 2,515,157,000	$ 1,602,304,000

Two things are quite evident from the press release. First, the spread between the high and low bid prices is quite small. On this 91-day issue, the spread between the high and low bid price is 0.7 cents on a $100 maturity value (the discount rate differential is 0.028 per cent). The spread between the average and the low, which may be a more relevant comparison, is 0.2 cents (0.009 per cent). Second, by far the largest volume of bidding occurs at the New York Federal Reserve Bank. In this particular instance the bids through the New York Federal Reserve Bank accounted for 67.7 per cent of the bids submitted, and 59.7 per cent of the bids accepted.

The majority of New York bidding is conducted by dealers in Government securities and the larger New York banks. Many of the small buyers of bills throughout the country do not bid directly for bills but rather have one of the larger New York banks place their bids. Therefore, a large New York bank will usually be bidding for its own account as well as for its "customers," that is, the small buyers. Only banks are permitted to submit tenders for other than their own account.

Government securities dealers bid for securities to sell to other accounts at a price higher than they pay. Dealers are in competition with each other in submitting their bids to the Treasury, and then must compete with each other in selling these bills after issue. Consequently, they wish to obtain the desired quantity of bills at the lowest possible price. A dealer who consistently bids too low would have no new issues of bills to sell, and if he consistently bids too high would have to sell his bills at a loss, or at least at a lower profit margin than more successful bidders.

With the money market "experts" submitting their bids at the New York Federal Reserve Bank--being aware of the moment by moment changes in the market--it would seem that the competitive bidders in New York would have a certain advantage over the bidders in the other Federal Reserve Districts. The situation at the New York Federal Reserve Bank near the close of the bidding for the weekly issue of Treasury bills has been described by Robert V. Roosa:

> Actually, most competitive tenders in New York are not submitted at the Federal Reserve Bank until the last half hour before the bidding closes; many arrive within the last minutes. The close physical proximity of the money market institutions to the Federal Reserve Bank permits the special transmittal of tenders by messenger.[32]

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[32]Robert V. Roosa, Federal Reserve Operations in the Money and Government Securities Markets (Federal Reserve Bank of New York, 1956), p. 38.

After the Treasury's Tuesday morning announcement, the bidders ascertain the quantity of bills that they will be awarded, and must pay for, on Thursday. Payments for the bills may be made by exchanging maturing bills, charging the reserve account at the district Federal Reserve Bank, or by draft. All bidders except incorporated banks, trust companies, and dealers in Government securities are required to deposit two per cent of the maturity value of the volume bid for at the time of submitting the tenders.[33]

After the Treasury announcement on Tuesday morning, the activity in the trading of United States Treasury bills shifts from the primary market to the secondary market. Government securities dealers begin marketing this new issue of bills on Tuesday morning on a "when issued" basis, attempting to dispose of their allotment before payment is required.[34]

The Mechanics of the Secondary Market

Dealers in United States government securities normally obtain approximately 20 to 25 per cent of the total weekly allotment from the Treasury.[35] Those bidders in the primary market who had their bids rejected, or who received only a partial allotment at the "stop-out" price, may buy those same bills in the secondary market from a Government securities dealer.

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[33]Tenders accompanied by an express guaranty of full payment by an incorporated bank or trust company also are exempt from the two per cent deposit.

[34]Gaines, op. cit., pp. 178-179.

[35]Ibid., p. 178. "Dealers themselves, as a group, usually bid to get allotments of about $300 million thirteen-week bills, and about $150 million twenty-six week bills, although this amount may vary considerably from one auction to the next, depending upon the outlook for secondary market demand for the bills.

Government securities dealers are willing to buy or sell any volume of bills of any maturity at almost any time. A transaction of a million dollars is considered small, and a transaction of $25 million to $30 million is considered large.[36] Practically all trading in all types of United States government securities in the secondary market is done through the Government securities dealers.[37] Trading of those Government securities that are near maturity dominates the market. The volume of trading in securities of less than one year to maturity accounted for between 70 to 80 per cent of total trading in the period 1951-1958. The volume of trading in Treasury bills alone have accounted for more than 50 per cent of the total transactions in every year over the same period.[38] Active trading takes place in all issues of Treasury bills. There are 13 different maturities of original 91-day bills outstanding at all times with the maturity dates spaced one week apart.[39] Since an original six-month bill with less than 91 days to maturity is perfectly substitutable for an original 91-day bill with the same number of days to maturity,[40] there are 13 different maturities of original six-month bills outstanding with maturity dates spaced a week apart, from 13 weeks to 26 weeks to maturity.

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[36] Allan H. Meltzer and Gert von der Linde, A Study of the Dealer Market for Federal Government Securities. Materials prepared for the Joint Economic Committee, 86th Congress, Washington, D. C., 1960, p. 19.

[37] Hereafter, government securities will mean United States Government securities unless further description is given.

[38] *Ibid*., p. 65.

[39] On a Thursday the longest maturity, normally, will be 91 days and the shortest maturity will be 7 days. However, on a Wednesday, the longest maturity normally will be 85 days and the shortest maturity 1 day.

[40] The six-month bills are assumed as companion issues to the 91-day bills. A six-month bill is scheduled to mature on the same day as that 91-day bill issued 13 weeks later.

The dealer charges no direct brokerage fee to either buyer or seller for making a transaction. A differential or "spread" is maintained between the price a dealer will pay for a particular bill and the price at which he will sell. Each dealer has a bid price (the price at which he is willing to buy) and an asked price (the price at which he is willing to sell), for each maturity of bills outstanding. Since bills are quoted on a yield basis, the bid yield will be higher than the asked yield (or in price terms the bid price will be lower than the asked price). The differential between the bid and asked yield is quite small. If on the same day a dealer could purchase and sell a bill with 71 days to maturity, quoted as 3.38 per cent bid and 3.30 per cent asked, he would make a gross profit of only 16 cents on a $1,000 transaction. However, the gross profit on a small transaction of $1 million would be $157.78, and on a transaction of $10 million the gross profit would be $1,577.80. The quoted differences between the bid and the asked yields are considered "outside" prices. A large trader could probably make a transaction at one-half the "outside" spread.

Almost all of the nonbank dealers use the same large New York bank for clearing operations.[41] The bank holds the securities for the dealers and makes a small charge of about ten dollars each time the securities are delivered to a new buyer. This cost, of course, is taken into account by the dealers in setting the differential between the bid and asked yields.

Market purchases are largely of two types, "regular" delivery or "cash" delivery. With "regular" delivery, the securities are delivered

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[41] Gaines, _op. cit._, p. 217: and Meltzer and von der Linde, _op. cit._, p. 25 and p. 112. The bank is listed as Manufactures Trust Company in the latter reference.

and payment made on the following business day. The "cash" purchase is delivered and paid for on the day of the order. "Regular" delivery is the normal method of sale. Payment may be in either Federal funds of clearinghouse funds.[42]

Dealers, unlike traders, maintain positions in, *i.e.*, an inventory or stock of, the securities they trade. A trader functioning as an agent, would simply arrange transfers between a buyer and seller. Positions in Government securities are maintained by dealers principally for the purpose of having various maturities of bills and other securities readily available for buyers, but cyclical fluctuations in positions reflect a degree of speculative activity.[43] The stock of Government securities in dealer's portfolios fluctuates cyclically--positions increasing with actual or anticipated declines in interest rates, and decreasing when rates move upward.

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[42] Gaines, *op. cit.*, p. 217. "...the contract may call for settlement in clearinghouse funds or Federal funds; all settlements made in funds located outside of New York are automatically in Federal funds, since settlement will be over Federal Reserve wires. There has been a tendency in recent years for more and more transactions in short-term securities to be for cash delivery and for settlement in Federal funds, and much the largest part of all transactions in such issues is now in this form."

For a distinction between Federal funds and clearinghouse funds, the following footnote is quoted from Scott, *op. cit.*, p. 101. "Federal funds are deposit liabilities of the Federal Reserve banks. Like currency, a draft on a Federal Reserve bank is cash in the sense that it can be immediately converted into deposits at a Federal Reserve bank. Clearinghouse funds, by contrast, are cash tomorrow. In other words, a draft on a Federal Reserve bank gives the holder immediate ownership of Federal funds. The holder of a check drawn on a commercial bank member of the New York Clearing House Association cannot acquire Federal funds until the next day. This is due to the fact that a bank presenting a check at the clearing will not receive credit for the check in his account at the Federal Reserve Bank of New York until the following day."

[43] Gaines, *op. cit.*, p. 210.

Although the types of securities making up dealer positions vary from time to time and from dealer to dealer, it appears that more than 90 per cent of the total position is made up of securities within five years to maturity.[44] The aggregate percentage holdings of bills, as an average of end-of-year figures for the dealers in 1953-1958, ranged from a low of 19 per cent to a high of 66 per cent of total holdings. Federal Reserve System data on the monthly average of daily net positions of Government securities dealers show that in the period January, 1961, through December, 1964, holdings of Government securities within one year of maturity fluctuated between a low of $1.6 billion and a high of $3.8 billion.

A great deal of the total trading in Government securities is interdealer trading. Published figures indicate that approximately 30 per cent of all trading is between dealers.[45] Dealers normally trade with one another in order to adjust their inventories. If a dealer's stock of a particular maturity becomes lower than desired, he may buy a quantity of these maturities from one or more other dealers. Dealers can, and do, ask other dealers for quotes on securities, and make purchases of those securities which they feel can be sold at higher prices. This type of interdealer trading tends to keep rates and spreads relatively constant among dealers. On an especially large transaction for a

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[44]The positions referred to here are net positions; that is, the difference between the gross "long" and gross "short" positions. Scott, op. cit., p. 98, defines a long position as buying securities and owning them, and a short position as selling securities he does not own and borrowing the securities to make delivery.

[45]The publication of positions and trading volume of Government securities dealers has been published in the Federal Reserve Bulletin since 1961. This data, in slightly different form, is available for the calender year 1958 in Part II of Treasury-Federal Reserve Study of the Government Securities Market, Board of Governors of the Federal System, 1960.

certain maturity, a dealer may sell short and be forced to buy from other dealers to obtain the quantity necessary for the transaction.

Over the period of this study, 1953-1964, the number of dealers recognized by the Federal Reserve System has varied between 15 and 20. In the period 1958-1959, in the study of the dealer market, Meltzer and von der Linde identified 17 dealers, 12 nonbank and 5 bank dealers; and at the time of Gaines's study (1961-1962), 19 dealers were operating, 13 nonbank and 6 bank dealers.[46] In addition, there are a great many brokers and commercial banks through which transactions may be executed. Nevertheless, these transactions usually end up being handled by one of the "central" Government securities dealers, especially if the transaction is a large one.

Substantial concentration exists in the dealer market. In the eleven years, 1948-1958, the three largest firms accounted for 43.4 per cent of the total transactions; the six largest, 61.5 per cent; and the eight largest, 82.8 per cent. This breakdown by total transactions is only slightly different from the concentration in trading of Treasury bills alone.[47]

As is evident from the fact that one-third of the dealers are banks, the dealers do not deal solely in Federal obligations. Most

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[46] Meltzer and von der Linde, _op_. _cit_., p. 2; and Gaines, _op_. _cit_., pp. 66-67. The dealers (1958-1959) were listed by bank and nonbank classifications. The bank dealers were: Bankers Trust Co., Chemical Bank New York Trust Co., Continental Illinois National Bank and Trust Co., First National Bank of Chicago, and Morgan Guaranty Trust Co. The nonbank dealers were: Bartow, Leeds & Co., Briggs, Schaedle & Co., Inc., C. F. Childs & Co., Inc., C. J. Devine & Co., Discount Corporation, First Boston Corp., Aubrey B. Lanston & Co., New York Hanseatic Corp., Wm. E. Pollock & Co., Inc., Chas. E. Quincey & Co., D. W. Rich & Co., Inc., and Salomon Bros. & Hutzler.

[47] Meltzer and von der Linde, _op_. _cit_., pp. 66-67.

dealers trade, in some degree, in state and local government securities, corporate bonds, and other financial instruments. There is also a degree of specialization in the types of Federal marketable securities traded. Some dealers do over 90 per cent of their total volume of trading in bills, while for other dealers bill trading constitutes only one-half of total volume. The percentage of trading in Treasury bills has increased over the period of analysis as bills have accounted for an increasing portion of the short-term Federal debt.

The volume of transactions in this market is immense. An indication of the relative size of the dollar volume for the Government securities market and other markets for a particular year is provided in the following quotation:

> Trading volume in the U. S. securities market is larger than the volume of transactions in any of the organized securities exchanges. Transactions on the New York Stock Exchange, for instance, amounted to $32.7 billion in common and preferred stock and $1.4 billion in bonds during 1958. This total NYSE trading volume compares with sales of U. S. securities through the dealer market of $176 billion in 1958. Data on the volume of transactions in corporate and municipal securities in the over-the-counter are not available but it is safe to assume that they would show a much smaller transactions volume in those markets than the 17 dealers have reported for the U. S. securities market.[48]

In the week ending November 18, 1961, the end of week average of daily volume showed gross transactions in Treasury bills alone as $1,554 million; made up of purchases of $689 million and sales of $865 million.[49]

Clearly, for a small number of dealers to handle such a large volume of securities, while maintaining large positions, an efficient

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[48] *Ibid*., p. 68.

[49] This information was supplied by the Market Statistics Division of the Federal Reserve Bank of New York.

form of financing must be available. Traditionally this financing was done through borrowing from the New York City money market banks. Recently, however, higher interest rates resulting from increased demand for short-term funds has forced dealers to look to additional sources for financing. Nonfinancial corporations, through the repurchase agreement,[50] have been providing increasing percentages of dealer financing.

The repurchase agreement is the sale of securities by a dealer, and a simultaneous agreement to "buy back" these securities at a specified future date. Typically, the repurchase agreement is for Treasury bills, and the duration must be less than 15 days (normally the duration is only one to five days). The sale price of the repurchase agreement and the price to be paid upon termination are computed to provide a specific rate of return to the buyer for the period of time that the repurchase agreement is undertaken.

The buyer is usually a bank, nonfinancial corporation, or the Federal Reserve System Open Market Account. Not only is the repurchase agreement of benefit to the dealer in financing his position, but benefit accrues to the buyer as well. In the case of a bank or nonfinancial corporation, the duration of the repurchase agreement can be arranged to make the funds available at precisely the time needed. For a bank, a repurchase agreement may serve as a slightly longer-term alternative to the lending of Federal funds, and may provide a slightly higher interest return. The nature of the repurchase agreement makes the risk of holding repurchase agreements based on bills even smaller than the risk of holding bills which are subject to price fluctuations between purchase and

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[50] Hyman Minsky, "Central Banking and Money Market Changes," The Quarterly Journal of Economics, LXXI (May, 1957), No. 2, pp. 176-178. Minsky provides an excellent description of the beginning of corporate participation in dealer financing.

sales date.[51] As an outlet for funds available for only one or two days, repurchase agreements provide an alternative not available through the purchase of bills in the open market. The normal spread between the bid and asked yields on bills does not justify the purchase of these instruments for a holding period so short.

The Federal Reserve Bank of New York, alone among the Federal Reserve banks, engages in purchases and sales of repurchase agreements with nonbank dealers. Bank dealers have access to borrowing through the discount privilege with the Federal Reserve Bank. The Federal Reserve Bank of New York may lend through repurchase agreements for up to 15 days on securities of less than 15 months maturity. In effect, termination of the agreement may be made by either party at any time; the duration of the agreements, however, are normally for periods shorter than one week.

The repurchase agreement is, from the point of view of the Federal Reserve System, a method of making temporary adjustment in commercial bank reserves, and in smoothing "money market pressures." The purchase and termination of repurchase agreements has the same effect on commercial bank reserves that open market activities accomplish. The "purchase" of a repurchase agreement from a dealer tends to increase bank reserves, and the "sale," or termination, of the agreement serves to decrease reserves. The Federal Reserve Bank of New York may choose this method of affecting bank reserves, instead of open market transactions, if the need for adjustment is clearly a temporary one, or if the desired impact of open market transactions is not yet clear.

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[51] Assuming yields do not change and a purchase and sale are made at the following yields, a bill with 70 days to maturity, quoted as 3.04 per cent bid and 3.00 per cent asked, would have to be held one day to break even.

"Money market pressures" arise in periods of tight money. When commercial banks are selling securities in order to increase their reserves, the positions of the dealers will increase even though the prices at which dealers are willing to buy are decreasing. In addition to the increasing inventory, dealers encounter difficulty in obtaining financing from their regular bank and nonfinancial corporate sources. Normally, in these periods, the New York Federal Reserve Bank will be a buyer of repurchase agreements to relieve the money market pressures from the dealers. When the Treasury is borrowing large amounts of new funds, similar pressures may fall on dealers as they carry larger positions in the securities and financing is difficult to obtain.

The sale of repurchase agreements to the New York Bank is initiated by the dealer.[52] Each day, from contacts with the dealers from the Trading Desk of the Federal Reserve Open Market Committee, the New York Bank is aware of the changes in dealer positions, and the resulting degree of difficulty in obtaining funds. The dealer requests to the New York Bank are made only after the regular bank and corporate sources prove insufficient for dealer needs, and before borrowing is attempted from some of the larger New York banks whose rates for short-term lending to dealers is consistently greater than the rate dealers pay to their more regular lenders.

The Federal Reserve Bank of New York normally charges the New York discount rate to dealers on the repurchase agreements, but may charge

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[52] Roosa, _op_. _cit_., pp. 83-87. A good, and quite detailed, discussion of the use of the repurchase agreement by the Federal Reserve Bank of New York is presented by Roosa. Evidently the responsibility has not always been with the dealer, Minsky, _op_. _cit_., pp. 176-177. Minsky indicates that prior to 1956, repurchase agreements with the New York Bank were initiated by the New York Bank.

the bill rate instead. The New York Bank never charges a rate that is lower than the discount or the bill rate. Repurchase agreements between the New York Bank and the nonbank dealers are usually for Treasury bills. For the Federal Reserve System, this temporary assistance in financing dealers' positions is important since smooth functioning of the market is crucial to carrying out countercyclical monetary policy.

Federal Reserve Operations in the Bill Market

Of the more important Federal Reserve System powers in executing monetary policy are: changes in reserve requirements of member commercial banks, changing the rediscount and advance rates, and buying and selling Federal securities in the open market. It is generally agreed that the most important of these powers is open market operations. If the intensity of use of these powers is an adequate guide to importance, open market operations can be considered as the tool used to exercise monetary policy.

Through the use of open market operations, the Federal Reserve System is making short-term adjustments in bank reserves to offset temporary and seasonal changes as well as influencing the stock of money and the interest rate (the assumption being that money supply and interest rate changes will in turn have some effect on the level of spending and investment). The Federal Reserve System, through directives issued by the Federal Open Market Committee, and carried out by the Manager of the System Open Market Account, is continuously buying and selling United States government securities in the open market. In the period of this analysis, 1953-1964, these open market operations were carried out almost entirely in Treasury bills. The method of using the open market technique, and the recognition of its value in monetary policy, have been evolving for several decades. The more recent innovations are of principal interest in this postwar study, and a general description of the relevant developments will be summarized in approximate chronological order.[53]

In the period 1942-1946, the rate on Treasury bills was pegged at 0.375 per cent. All other Government securities had supported rates, and the Federal Reserve System used open market transactions to maintain a yield pattern that approximated the prewar rates. On July 2, 1947, the Treasury and the Board of Governors of the Federal Reserve System agreed to end the pegging of rates. In regard to the bill rate, the reason for this action was obvious. The Federal Reserve Banks held practically all Treasury bills outstanding. Of $16 billion outstanding, the Federal Reserve Banks held all but $1.5 billion.[54] The Certificate of Indebtedness, yielding around 0.8 per cent and posted at that level, had forced the elimination of the Treasury bill (with the rate posted at 0.375 per cent) from the short-term market. Only six months after the Federal Reserve Banks abandoned support, the bill rate climbed to near one per cent.

Between 1947 and 1951, the Federal Reserve System used open market operations to maintain "orderly" yields on Government securities thereby assisting the Treasury in debt refinancing operations, while at the same

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[53]For a detailed description of the goals of monetary policy during the complete period and on evaluation of the effectiveness of the policies see: Daniel S. Ahearn, Federal Reserve Policy Reappraised, 1951-1959 (New York: Columbia University Press, 1963). Ahearn's survey of the events leading to the accord, and the arguments regarding "bills only" are especially relevant. Also of merit is: United States Monetary Policy Revised Edition (Ed.) Neil H. Jacoby (New York: Frederick A. Praeger, Published for the American Assembly, Columbia University, 1964).

[54]Thirty-Fourth Annual Report of the Board of Governors of the Federal Reserve System Covering Operations for the Year 1947, pp. 92-93.

time attempting to buy and sell securities to affect member bank reserves in accordance with general economic conditions. The two goals were generally conflicting.

The Federal Open Market Committee desired to operate more freely in executing open market transactions to attain the goals of flexible contracyclical monetary policy. The Treasury resisted the System's efforts to reduce the degree of debt management support as long as possible. But on March 4, 1951, the Federal Reserve System and the Treasury issued the following announcement:

> The Treasury and the Federal Reserve System have reached 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 monetization of the public debt.[55]

Throughout 1951 and into 1952, the short-term market operated with less direct support from open market transactions of the Federal Reserve System. The Open Market Account was a supplier to the market for short-term securities, and also reduced their holdings in the short-term issues by allowing securities to run off without replacement as they matured. However, in the fall of 1952, the Federal Reserve System again supported Treasury financing of a large issue of Certificates of Indebtedness.

On March 5 and 6, 1953, the Federal Reserve Open Market Committee agreed to change the wording of a directive of December 8, 1952, relating to the policy of supporting interest rates on Treasury obligations. Significant policy implications are apparent in the change in wording

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[55] Thirty-Eighth Annual Report of the Board of Governors of the Federal Reserve System Covering Operations for the Year 1951, p. 4. Additional details are given in the same source on pages 99-101. Also see Allan Sproul, "The 'Accord' - A Landmark in the First Fifty Years of the Federal Reserve System," Monthly Review, Federal Reserve Bank of New York, Vol. 46, No. 11 (November, 1964), pp. 227-236.

from: "...maintaining orderly conditions in the Government securities market," to the approved form "...correcting a disorderly situation in the Government securities market."[56] This statement constituted another step in carrying out the intent of the Federal Reserve System in the Statement of Accord of 1951, and further signified the desire for "independence" by the Federal Reserve Board of Governors to exercise contracyclical monetary policy. In addition to the change in wording of the directive, the following policies were approved by the Federal Open Market Committee:

> (1) Under present conditions, operations for the System account should be confined to the short end of the market (not including correction of disorderly markets);
>
> (2) It is not now the policy of the Committee to support any pattern of prices and yields in the Government securities market, and intervention in the Government securities market is solely to effectuate the objectives of monetary and credit policy (including correction of disorderly markets);
>
> (3) Pending further study and further action by the Committee, it should refrain during the period of Treasury financing from purchasing (1) any maturing issues for which an exchange is being offered, (2) when-issued securities and (3) outstanding issues of comparable maturity to those being offered for exchange.[57]

The policy of exercising open market transactions in the short-term maturities was confined primarily to the purchase and sale of Treasury bills.

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[56] Fortieth Annual Report of the Board of Governors of the Federal Reserve System Covering Operations for the Year 1953, p. 87.

[57] Ibid., p. 88. Excellent reviews of open market policies are available in: Clay J. Anderson, A Half-Century of Federal Reserve Policymaking, 1914-1964 (Federal Reserve Bank of Philadelphia, 1965); and David P. Eastburn, The Federal Reserve on Record: Readings on Current Issues from Statements by Federal Reserve Officials (Federal Reserve Bank of Philadelphia, 1965).

The Federal Reserve deviated from the so-called "bills only" policy infrequently, and then only temporarily, to correct disorderly markets for Government securities.[58] In December, 1955, the Federal Open Market Committee authorized purchase of up to $400 million of Certificates of Indebtedness dated December 1, 1955, and maturing a year later. The Federal Reserve actually purchased $267 million of this issue.[59] In February, 1957, as the Manager of the Federal Open Market Account was carrying out the monetary policy directives of the Federal Open Market Committee to sell securities, the supply of bills was reduced to a level of slightly more than $100 million, and Certificates and notes were sold in the open market instead of bills.[60] In July, 1958, several maturities

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[58] No attempt is made here to evaluate the "bills only" policy. Interest in this study lies principally in the effect of the policy on the bill market in that total transactions in bills are greater than under a policy under which all maturities are traded.

The "official" arguments supporting "bills only" are: "The Economics of 'Bills Preferably'," The Quarterly Journal of Economics, LXXIV, (August, 1960), pp. 341-373; and Winfield W. Riefler, "Open Market Operations in Long-Term Securities," Federal Reserve Bulletin, XLIV, (November, 1958), pp. 1260-1274.

Representative criticisms are available in: Paul A. Samuelson, "Recent Monetary Controversy," The Three Banks Review, (March, 1959), pp. 3-21; Warren L. Smith, Debt Management in the United States, Study Paper No. 19 of materials prepared in connection with the Study of Employment Growth, and Price Levels, Joint Economic Committee, Washington, D. C., 1960; Sidney Weintraub, "The Theory of Open Market Operations: A Comment," The Review of Economics and Statistics, XLI, (August, 1959), No. 3, pp. 308-312; and David I. Fand and Ira O. Scott, Jr., "The Federal Reserve System's 'Bills Only' Policy: A Suggested Interpretation," The Journal of Business, (January, 1958), XXXI, No. 1, pp. 12-18.

[59] Forty-Second Annual Report of the Board of Governors of the Federal Reserve System Covering Operations for the Year 1955, pp. 109-110.

[60] Federal Reserve Bank of New York. Forty-Third Annual Report for the Year 1957, p. 26. Also see: Edward J. Geng, United States Treasury Bills: Liquidity and the Growth of the Market, mimeographed version of Master of Business Administration Thesis, New York University, 1962, p. 58.

in addition to bills, including some long-term issues, were purchased by the Federal Reserve System in order to correct disorderly market conditions.[61] These three instances were the only departures from the "bills only" policy between its adoption and late 1960 when international monetary problems stimulated a reconsideration of monetary policy goals.

The presumed acuteness of the balance-of-payments problem, and the continuing outflow of gold from the United States, was intensified as the 91-day bill rate in the open market fell to a low of 2.13 per cent in August, 1960, while the market three-month bill rate in the United Kingdom moved to 5.6 per cent and the "discount rate" of the Bank of England was 6 per cent. In October, 1960, in order to ease the downward pressure on the bill rate from open-market purchases, the Federal Reserve System began to purchase securities in the open market with maturities of one to five years. On February 20, 1961, the Federal Reserve began purchasing notes and bonds, some with maturities in excess of five years.[63] The policy of conducting open-market operations with longer-term maturities, as well as bills has continued through 1964. In addition, the Treasury, in refinancing the Federal debt and in financing new debt, has increased the quantity of Treasury bills outstanding in an effort to increase the short-term interest rates.

Although the "bills only" policy seems to have been temporarily terminated, the bulk of system open market transactions are in Treasury

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[61] Forty-Fifth Annual Report of the Board of Governors of the Federal Reserve System Covering Operations for the Year 1958, p. 69.

[62] "Interest Rates in Leading Countries," Federal Reserve Bulletin, Vol. 47, (August, 1961), No. 8, p. 894.

[63] Forty-Eighth Annual Report of the Board of Governors of the Federal Reserve System Covering Operations for the Year 1961, p. 43.

bills. Table 1 shows the yearly total outright transactions in bills and in the maturity categories: within one year, one to five years, and over five years.[64] Even in 1961 and 1962 when non-bill transactions were relatively great, bill transactions were several times greater than the combined transactions of all other categories.

Public Holders of Treasury Bills

Although the Federal Reserve System is clearly the single most important trading force in the market, the combined holdings of several investor groups are larger. The individual institutions in these groups tend to act in unison in their market behavior, and therefore have a great influence on the aggregate demand for Treasury bills. The bill holdings of the principal bill holding groups will be briefly reviewed.

Information regarding ownership of Treasury bills is derived almost entirely from monthly estimates made in the "survey of ownership" by the Treasury and published in the Treasury Bulletin. The accuracy of these data ranges from excellent for Federal government agencies and trust funds, the Federal Reserve System, and member commercial banks; to practically nonexistent for foreign governments and banks, nonfinancial corporations, and state and local governments. For most of the period 1953-1964, no ownership data for Treasury bills are available for nonfinancial corporations and state and local governments. Recently, estimated ownership data from survey information was initiated for these two sectors. For nonfinancial corporations, sample survey data on bill holdings extend back to February, 1960; for state and local governments, data

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[64] These transactions are outright, therefore not including repurchase agreements.

TABLE 1.--Maturity distribution of total outright transactions of the Federal Reserve System, (in millions of dollars)

Year	Treasury Bills			Coupon Issues Maturing					
				Within 1 year		In 1-5 years		After 5 years	
	Purchases	Sales	Redemptions	Purchases	Sales	Purchases	Sales	Purchases	Sales
1954	2,903	1,354	1,978	--	--	--	--	--	--
1955	2,009	1,416	1,257	167	--	--	--	--	--
1956	3,125	2,018	888	--	--	--	--	--	--
1957	2,407	2,161	984	--	153	--	--	--	--
1958	5,489	2,633	1,590	1,200	--	10	--	55	--
1959	2,866	1,574	937	--	--	--	--	--	--
1960	4,370	2,631	1,445	202	218	113	14	--	--
1961	5,794	4,486	1,015	600	1,474[a]	1,923	97	788	--
1962	6,813	6,211	1,353	1,085	402	1,569	108	362	--
1963	7,291	4,360	1,232	56	54	844	50	609	--
1964	9,433	5,437	2,093	5	--	465	--	551	--

[a]Excludes $295 million of maturing issues.

Sources: Stephen H. Axilrod and Janice Krummach, "Federal Reserve Security Transactions," Federal Reserve Bulletin, Vol. 50, No. 7 (July, 1964), Appendix Table 2, p. 837. Data for 1964 are from the Fifty-First Annual Report of the Board of Governors of the Federal Reserve System Covering Operations for the Year 1964 (Washington, D. C.: Board of Governors of the Federal Reserve System, 1965), p. 228. The Treasury bill data for 1964 is not exactly on the same basis as for the years 1954-1963.

are available from December, 1960. The investor groups and the number of institutions that are presently surveyed by the Treasury are summarized in Table 2. Also included in the table is the Treasury's estimate of the percentage of the total sector holdings covered by the survey.

TABLE 2.--Coverage of the U. S. Treasury survey of ownership as number of reporting institutions in each sector, and the estimated percentage of total holdings of the surveyed institutions to total holdings for each sector

Sector	Approximate Number of Reporting Institutions	Approximate Percent of Total Sector Holdings
Government agencies and trust funds	a	100
Federal Reserve Banks	a	100
Commercial banks	6,200±	90
Mutual savings banks	500+	90
Life insurance companies	300+	90
Fire and casualty insurance companies	500+	90
Savings and loan associations	490±	50
Nonfinancial corporations	470±	50
State and local governments	500±[b]	70[b]

[a]The Treasury survey combines the holdings of Government agencies and trust funds and the Federal Reserve Banks. The figures are given separately in a summary table of the Treasury ownership data, in the Federal Reserve Bulletin.

[b]The size of the survey for this category was increased in January, 1964 from 295 general funds to 316 general funds, plus approximately 190 pension and trust funds.

Source: Treasury Bulletin, monthly issues, 1953-1964.

It should be pointed out that the percentage holdings of each sector is the estimated percentage of total Government securities held by a particular sector, and no further breakdown is provided as to the estimated holdings of each type of security as a percentage of total sector holdings.

The principal investor sectors that are not now included in the Treasury survey of ownership are dealers and brokers in Government securities, and foreign governments and banks. The Federal Reserve Bank of New York has been collecting both positions and transactions of Government securities dealers since the Treasury-Federal Reserve investigation of the dealer market in 1959. These data are available (not necessarily in comparable form) back to November 1957. In its present published form, holdings are given by maturity groupings and not by types of securities. For the international sector estimates of the combined holdings of Treasury bills and Certificates are available on a monthly basis from 1950.[65]

From the published data on bill holdings, it is possible to estimate roughly the importance of the different investor groups in the Treasury bill market. In the following discussion an attempt will be made to indicate the approximate bill holdings of the principal investor groups as of the end of December, 1964. This estimate will be only a very rough approximation, and is subject to a great deal of discretion and pure guesswork. The purpose in attempting to estimate sector holdings is to illustrate the relative importance of sector demand for bills.[66]

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[65] Supplement to Banking and Monetary Statistics, Section 15, "International Finance," Board of Governors of the Federal Reserve System, March, 1962.

[66] The estimation of bill holdings follows the general method used by Edward J. Geng, op. cit. Also useful in this attempt is Michael E. Levy, Part I, Federal Debt and Its Ownership, Cycles in Government Securities, National Industrial Conference Board, 1962.

As of December 31, 1964, there were $56.5 billion in Treasury bills outstanding, which represented 26.6 per cent of total outstanding marketable Federal debt, and 63.8 per cent of marketable Federal debt within one year of maturity or first call.[67]

Government agencies and trust funds

The Government agencies and trust funds secure Treasury bills through the Federal Reserve System, which acts as the agent. Most of the holdings of the trust funds are concentrated in the Old Age and Survirors Insurance fund, the Unemployment Insurance Trust Fund, the Civil Service Retirement and Disability fund, and the Railroad Retirement account.[68] Although these holdings move modestly in cyclical patterns (and somewhat seasonally), they are characterized basically by an upward trend. Most of the security holdings by the Government sector are relatively long-term, and bill holdings are small. The effect of bill holdings by the Government sector is a net reduction in the supply of bills available in the market. Holdings by Government agencies and trust funds as of December 31, 1964 were $1.3 billion, only 2.3 per cent of total bills. These bill holdings represented 75.6 per cent of agency and trust funds holdings of the "within one year" maturity, but only 10.8 per cent of total sector holdings of marketable Federal securities.

Federal Reserve Banks

As has been pointed out earlier, bill holdings by the Federal Reserve System move in a cyclical fashion (although in the opposite

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[67]The quantity of bills outstanding is always measured as the value at maturity.

[68]Gaines, op. cit., p. 146.

direction to most other cyclical holders), as well as seasonally and at times seemingly in irregular patterns. At the end of December, 1964, the Federal Reserve Banks held $6.5 billion of Treasury bills, representing 11.5 per cent of total bills outstanding. Of total Federal Reserve holdings of marketable Federal debt, bills constituted 17.5 per cent; of total portfolio holdings of Federal securities maturing within one year, bills made up 30.3 per cent. Bills not held by Federal government agencies and trust funds and by the Federal Reserve System, are classified by the Treasury survey as "held by the public."

Commercial banks

Treasury bills are part of those liquid assets in commercial bank portfolios considered "secondary" reserves. Although bill holdings move cyclically, the pattern is not clearly apparent.

In 1952, bill holdings of commercial banks had increased into the vicinity of $6 to $7 billion, declining rather rapidly from this level to a low of slightly less than $2 billion in 1956 and fluctuating between $3 and $5 billion throughout 1957-1959. In mid-1960, bill holdings moved to a secondary low of $2.5 billion, then rose sharply to $9 to $10 billion in 1961. Since mid-1961, bill holdings declined to $6.5 billion in mid-1962, increased to the $10 billion level in November, 1962, and have fluctuated between $6 and $11 billion through 1964. An apparent explanation of the great increase in holdings from mid-1960 is the action by the Treasury in increasing bills outstanding and beginning the regular issue of six-month, nine-month, and one-year bills, using these securities to replace Certificates of Indebtedness. Bills in 1960-1961 began to make up a larger proportion of short-term United States Government securities.

The explanation of commercial bank portfolio policy is very complex and there is some controversy among economists regarding behavior of bank holdings of marketable Federal securities during cyclical fluctuations. It has been frequently suggested that when bank reserves are under pressure, banks would liquidate short-term Government securities; however, Dudley G. Luckett has recently indicated that banks probably liquidate long-term securities instead.[69] On a shorter-term basis, monthly seasonal movements are apparent in the bill holdings of commercial banks, and since bill holdings for December are being compared for the different sectors, it should be pointed out that commercial bank holdings for December are seasonally above holdings for any other month.[70]

The movement of bank holdings of bills over the period 1953-1964 does not represent any simple upward or downward trend movement, and it has been indicated that some structural shifts have possibly occurred in bank holdings of bills.[71]

Bill holdings on December 31, 1964, according to the Treasury survey, amounted to $11.0 billion. Of those banks reporting in the survey, this quantity of bills represented 20.4 per cent of total bank holdings of Federal marketable debt, and 59.3 per cent of bank holdings of securities within one year to maturity.

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[69] Dudley G. Luckett, "Compensatory Cyclical Bank Asset Adjustment," The Journal of Finance, XVII, (March, 1962), No. 1, pp. 53-62.

[70] See Chapter VIII below; also William H. Brown, Jr., Forty-Third Annual Report of the National Bureau of Economic Research, The Uses of Economic Research, New York, 1963, pp. 78-81. Brown has generously provided preliminary results of his seasonally adjusted data relating to the Treasury bill market.

[71] Minsky, *op. cit.*, pp. 179, 185-187.

Since the Treasury survey covers approximately 90 per cent of bank holdings, a 10 per cent increase in the quantity of bill holdings reported in the survey would indicate holdings of all commercial bnaks to be around $13.2 billion.[72] This amount represents 23.4 per cent of the total quantity of bills outstanding.

Nonfinancial corporations

Although the information on bill and Government securities holdings has been available only since 1960, it has been known for some time that corporations were large holders of short-term Federal debt, and particularly Treasury bills.[73] From a survey questionnaire in 1956, it was learned that, "for a time this spring, General Motors held more Treasury bills in its investment portfolio than did the entire Federal Reserve System."[74] Corporate holdings seem to move seasonally, with large holdings of bills and tax-anticipation issues preceding the quarterly tax dates, followed by a rather abrupt decline in the weeks following payment dates. Empirical studies suggest that corporate holdings of Treasury securities are closely related to their accrued Federal tax liabilities,

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[72] The semi-annual commercial bank survey in the February, 1965 Treasury Bulletin indicates that the nonmember banks held $1.7 billion in bills, which would give a total of member plus nonmember holdings as $12.7 billion. The approximate increase of 10 per cent yields an overestimate in this case.

[73] The exact importance and extent of these holdings over the period 1952-1956 is questionable. See Colin D. Campbell, "Investments in United States Government Securities by Nonfinancial Corporations, 1952-1956: Comment," and Hyman P. Minsky's "Reply," The Quarterly Journal of Economics, LXXI, (May, 1958), No. 2, pp. 292-300.

[74] Charles E. Silberman, "The Big Corporate Lenders," Fortune, (August, 1956), as reprinted in (Ed.) Lawrence S. Ritter, Money and Economic Activity (2d ed., Boston: Houghton Mifflin Company, 1961), p. 127.

and are not very responsive to interest rate changes.[75] As corporations become more adept in managing their cash flows and as interest rates have risen secularly since World War II, a greater percentage of their idle balances are being held in the form of Treasury bills, short-term issues, and repurchase agreements. The holding of short-term instruments has shown an upward trend over the period of analysis, but since this conclusion has been pieced together from several empirical studies, the degree of trend in holdings is not known. William J. Frazer, Jr., in an empirical study, has commented that:

> It appears that the view is increasingly taking hold among these corporations that the return from expert management of the cash account is well worth the effort. Further, as a result of this improved management of the cash account, adjustments in cash needs are primarily made by changes in the holdings of United States government securities.[76]

The Treasury survey showed that for the 469 corporations responding for December, 1964, bill holdings totaled $5.0 billion. Of this total, $3.1 billion were in regular weekly issues, $0.6 billion in longer-term bills, and $1.4 billion in tax-anticipation bills. Bill holdings of the corporations surveyed represented 55.2 per cent of total holdings of all Treasury securities held by these 469 corporations, and 74.7 per cent of those securities within one year to maturity.

Since the Treasury survey is based on a sample that includes approximately 50 per cent of total corporate holdings, it would be

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[75] Nancy Teeters, "Nonfinancial Corporations Holdings of U. S. Government Securities," mimeographed, 1961; and "Corporate Participation in the Government Securities Market," Monthly Review, Federal Reserve Bank of Kansas City, (December, 1960), pp. 9-15.

[76] William J. Frazer, Jr., "Large Manufacturing Corporations as Suppliers of Funds to the United States Government Securities Market," The Journal of Finance, XVIII, (December, 1958), No. 4, p. 503.

estimated that all nonfinancial corporations held in the vicinity of $10 billion, or roughly 18 per cent of all bills outstanding. In addition, 17,816 corporate pension and trust funds held $.6 billion in bills at the end of 1964.

State and local governments

In the Treasury survey of ownership, holdings of state government pension funds are listed separately from holdings by general funds. Since the holdings of the pension funds are relatively small, they are grouped in with holdings of the general funds. State and local government holdings of short-term Treasury securities and Treasury bills, depend primarily on the temporary surpluses of receipts over expenditures as taxes are collected at the end of periods, and used during subsequent periods. Also, those funds that may have been raised through borrowing for use on predetermined construction projects are channeled into highly liquid, short-term, riskless securities until needed. Given the trend in state and local expenditures, it is expected that the upward trend of the last several years will continue. Although state and local governments keep Federal securities in their portfolios at the short end of the maturity scale, a smaller percentage of their total holdings are in bills than for nonfinancial corporations.

On December 31, 1964, the 316 state and local government general funds included in the Treasury survey held $3.7 billion in bills, and 191 pension and retirement funds held $.219 billion. For the surveyed general funds, bill holdings represented 81.5 per cent of total holdings of Federal securities within one year to maturity, and 26.4 of total sector holdings of Federal securities.

As of December, 1964, the Treasury estimates that about 70 per cent of total state and local holdings are included in the ownership data. Making a rough increase in the reported general fund, bill holdings of 30 per cent indicates that approximately $4.8 billion was held at the end of the year, 1964 and adding $.2 billion for pension funds yields an approximation of $5.0 billion. This total is approximately 8.8 per cent of the total quantity of bills outstanding.

Dealers

Bill holdings of dealers in Treasury securities are subject to a great deal of variation, even within a period as short as a day. Bill holdings follow a within-week pattern because of the Monday auction by the Treasury and the disposition of these newly issued bills during the week. There is also a longer-term seasonal pattern, with dealers' positions reflecting the seasonality of all other holders, as dealers are forced to absorb this seasonal trading into their positions.

No trend is clearly apparent in the fragmentary data available.[77] The cyclical holdings of dealers reflect larger positions as rates decline (prices rise) and smaller positions as rates increase (prices fall).

Since the Federal Reserve Bulletin data covering dealer positions are weekly averages of daily holdings, the holdings of this group will be viewed as the daily average for the week ending December 30, 1964. For that date, the average daily position in maturities of less than one year was $3.3 billion, or approximately 85 per cent of total dealer holdings.

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[77] A Study of the Dealer Market, *op. cit.*, pp. 27-48. Also, *Treasury-Federal Reserve Study of the Government Securities Market*, Part II, *op. cit.*, Appendix C, pp. 138-139; the breakdown in the dealer position by type of security is available from October 1957 through December 1958.

On the basis of bill holdings relative to holdings of the one-year maturity category on the same date for 1960, it appears that bills account for around 70 per cent of the one-year classification. This yields a crude estimate of bill holdings of approximately $2.7 billion.

Dealer holdings include bank dealers, and therefore the estimated bill holdings involve double counting if bank dealers' holdings are included with both dealers and banks. Nevertheless, it is interesting that the fifteen to twenty dealers probably held around 5 per cent of all bills outstanding.

Foreign governments and banks

In the period 1953-1964, holdings of Treasury securities by the foreign sector have moved consistently upward. This movement has been due largely to increasing dollar claims against the United States. A balance of payments shift would probably reverse this trend; and exogenous factors such as devaluation of currencies, political problems, or a deepening of international tensions would probably cause irregular movements in these holdings.

Foreign holdings are highly concentrated in short-term issues. In December, 1964, foreign governments and banks were reported as holding $8.8 billion in Treasury bills (since no Certificates of Indebtedness are outstanding). This amount does not include approximately $3.3 billion of non-negotiable, non-interest-bearing special United States notes held by the International Monetary Fund. The breakdown of the $8.8 billion by geographical areas include the following: Europe - $5.6 billion, Canada - $0.8 billion, Latin America - $0.2 billion, and Asia - $1.0 billion. Foreign holding of bills account for 15.6 per cent of total bills issued.

Foreign holdings of Treasury notes and bonds excluding international agencies totaled $1.5 billion on the above date, which added to the $8.8 billion holdings in bills and Certificates would indicate total holdings by foreign governments and banks as $10.3 billion. Bill holdings constitute 85 per cent of total holdings of Treasury securities by the foreign sector.

Other public holders

Data on bill holdings by life insurance companies, fire and casualty insurance companies, and mutual savings banks are based on a rather complete survey, and are available for the complete period. Treasury security holdings by these groups generally have declined since the war, and bill holdings at present are relatively unimportant in their portfolios. Although the survey information for savings and loan associations covers only 50 per cent of holdings, and does not extend back prior to the beginning of 1960, it is evident that this group is not an important holder of Treasury bills. Because of the limited importance of these groups in the bill market, it has been decided to lump them together into a group considered to react similarly in their market behavior.

As of December 31, 1964, bill holdings of this combined group totaled approximately $1.3 billion which is only 6.5 per cent of the combined holdings of the group in United State Treasury securities, but 55.6 per cent of holdings by the group of Treasury securities maturing within one year. The combined holdings represent approximately 2.3 per cent of total bills outstanding.

No information whatsoever is available for holdings of Treasury bills by individuals. They are included in the Treasury with "all others," which includes the residual of the groups above who are not completely surveyed, and those groups not reporting to the survey. The residual holdings represent a larger percentage for Treasury bills than for any other security classification. Over the period, residual holdings range from around 80 per cent of bills outstanding in 1953 to around 40 per cent in 1964.

Summary and Conclusions

The attempt to account for the ownership of all Treasury bills at a particular point of time has yielded very imprecise results as approximately $7 billion, or 12.5 per cent of total bills outstanding remain in the residual category. It should also be stressed that the procedure used to increase the bill holdings of investor groups is tenuous. The quite naive assumption is that if the Treasury survey covers 50 per cent of a sector's holdings, this represents 50 per cent of each type of security and each maturity classifications. Table 3 summarizes the holdings of various investor groups but it should be interpreted as an extremely rough estimate.[78]

Bill holdings by commercial banks and the Federal Reserve System are relatively large, volatile, and (perhaps most important for a statistical analysis) accurately reported over the relevant period. Bill holdings for banks in leading cities are available on a weekly basis which might permit some view of at least a portion of the banking sector during within month periods. Data on holdings of other investor groups are

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[78]Teeters, op. cit., p. 18. "Observation...indicates that a much larger percentage (somewhere in the neighborhood of 70 to 80 per cent) of the change in total corporate holdings was accounted for by the holdings of the large corporations reporting directly to the Treasury."

TABLE 3.--Estimated Treasury bill holdings of investor sectors on December 31, 1964, as total holdings, percentage of bills outstanding, percentage of marketable U. S. Treasury securities in sector portfolios maturing within one year, and as percentage of sector holdings of total marketable U. S. securities

Type	Bill Holding			
		As Per Cent of		
	Amount ($ billion)[a]	Bills Outstanding	Marketable U. S. Securities: Maturing Within One Year	Marketable U. S. Securities: Total
Total	56.5	100	63.8	26.6
Government agencies and trust funds	1.3	2.3	75.6	10.8
Federal Reserve Banks	6.5	11.5	30.3	17.5
Commercial banks	13.2	23.4	59.3	20.4
Nonfinancial corporations	10.0	17.7	74.7	55.2
Corporate pension and trust funds	.6	1.1	70.0	27.6
State and local governments	5.0	8.8	81.5	26.4
Dealers	2.7	4.8	80-90	60-80
Foreign	8.8	15.6	?	85.4
Combined insurance and mutual savings banks	1.3	2.3	55.6	6.5
Individuals, others, and residual	7.1	12.5	--	--

[a]Details do not add to total because of double counting when bank dealers were classified both as banks and dealers. Rounding also enters into totals.

Sources: Treasury Bulletins and Federal Reserve Bulletins.

either not available over the desired period, or relatively unimportant to total bill holdings. In the empirical portion of the analysis, Chapter VIII, attention will be concentrated on the bill holdings of these surveyed sectors. The lack of holding data for some sectors and data for short periods for other sectors severely limits the ability to measure the effect on the bill rate of demand changes.

CHAPTER III

THE MOVEMENTS OF THE BILL RATE

Introduction

It is necessary to make a choice of a single rate among the different measures of the bill rate available before attempting to describe the movements in the Treasury bill rate. Measures of the bill rate are regularly published for 91-day bills, six-month bills, nine-month and one-year bills, as well as for tax-anticipation bills, on a yearly, monthly, weekly, or daily basis. Since the longer-term bill issues are a relatively recent development and since tax-anticipation bills do not provide a continuous series, the analysis will be confined to the rate on the 91-day bill.

Monthly and weekly average 91-day bill open market rates are available from the Federal Reserve Bulletin. These average rates are computed from daily closing bid prices collected from Government securities dealers. The Treasury publishes the full details of the weekly auction results in the Treasury Bulletin and in the Annual Report of the Secretary of the Treasury on the State of the Finances. Actually, three rates are available from these auction data; the yields computed from the reported high bid price, the low accepted bid price, and the mean of the accepted bid prices.

Since the present purpose of analyzing the Treasury bill rate time series is to gain information on the relative magnitude of movements due to different factors, and not necessarily to compute a usable seasonally adjusted series, the monthly average of daily closing bid yields is adequately precise and will serve as the basis for the statistical calculations.

Actually, the monthly average of closing bid yields is not a single average but a combination of several averages. There are at least four different aspects of this problem of averages. First, this is an average of 13 different bill rates, one rate for each different weekly issue outstanding. The average rate on these 13 different issues should not be confused with the rate for a bill with exactly 91 days to maturity. The 13 issues outstanding were all originally 91-day bills, but the maturities are spaced one week apart from 13 weeks to one week to maturity. The average time to maturity computed over a period of time would be 46 days, ranging from a mean time to maturity of 49 days for Thursdays to a low of 43 days to maturity on Wednesdays.[79] Second, this average is an average of the closing bid yields of each of the reporting dealers. Normally yields will be very closely grouped for all dealers, but price differences among dealers existing at the time of the market close are averaged. Third, it is the average of the daily closing yields for all trading days in the month. The closing yield is computed from dealers' quoted prices, which are not necessarily the prices at which transactions take place. Since these are bid prices, the observation error will probably be less than if the offer price were used because it seems that the

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[79]See footnote 39, Chapter II, p. 24.

offer price might be more subject to bargaining by a potential buyer than the bid price would be by a potential seller. Fourth, this yield is computed from the average of dealers' closing prices, and is published to two decimal places (for example 2.63 per cent), which is clearly a rounded figure. There will also be some bias to the quoted monthly average rate depending on the first and last trading day of the month, especially if there is within-week variation in the bill rate. For example, if a month both begins and closes on trading days which may be within-week highs, then the monthly average rate may be slightly biased upward. These observation errors are relatively unimportant for our purposes, and are pointed out to indicate that the average monthly rate being used in the following calculations is not a precise measure of the rate that is being described. The degree of accuracy is taken into consideration in rounding the calculated figures below. Throughout this Chapter the bill rate is given in terms of bank discount.

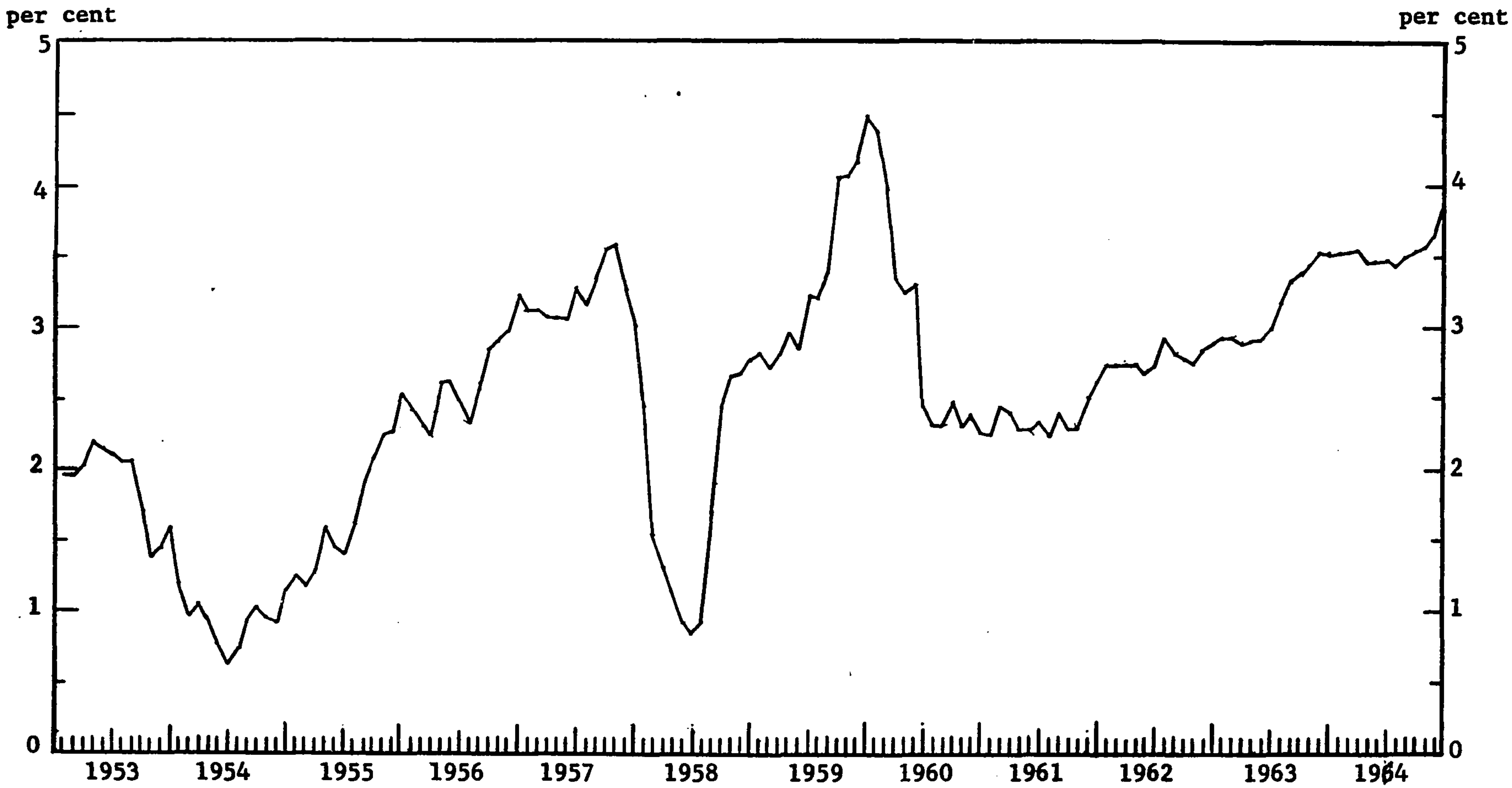
The weekly auction rates from the Treasury sources will be used to make estimates of the variations in the bill rate that occur within time periods shorter than one month. These rates are slightly more accurate calculations than the monthly average rate described above. The mean of the accepted bids (the price at which the noncompetitive bids are filled) will be the specific rate used. This rate is an average of the accepted competitive bids, and is computed from the weighted average of the bid prices which are required to be to exactly three decimal places (for example, $99.389).

The Treasury bill rate is quite volatile, at times showing large fluctuations over a short period of time. The mean average monthly bill rate for the period 1952-1964 is 2.462 per cent, with a standard deviation of .82 per cent, yielding a coefficient of variation of .33. The frequency distribution of the monthly average of daily open market bill rates for the same period is shown in Table 4. The frequency distribution has been divided into classes with convenient intervals of 0.5 per cent and has not been constructed for the purpose of analysis. It is intended to be descriptive only, illustrating the general characteristics of the magnitude of the monthly bill rates over this period; and the classes were formed to facilitate comparison of the frequency distribution with the bill rates plotted in the time series of Chart 1. The rates have not been generated randomly through time, and a frequency distribution covering a different period of time would appear very different. This is easily discerned by viewing the monthly average open market bill rate shown in Table 5 and illustrated graphically in Chart 1.

TABLE 4.--Frequency distribution of the monthly average of daily closing bid yields, 91-day Treasury bills, 1952-1964

Yield Class	Number in Class	Percent in Class
.50- .99	11	7.0
1.00-1.49	12	7.7
1.50-1.99	21	13.5
2.00-2.49	35	22.4
2.50-2.99	34	21.8
3.00-3.49	25	16.0
3.50-3.99	13	8.3
4.00-4.49	5	3.2
Total	156	99.9

Source: Various issues of Federal Reserve Bulletin.



Source: Table 5

Chart 1.--Treasury 91-day bill rate, monthly average of daily closing bid yields, 1953-1964.

TABLE 5.--Treasury 91-day open-market bill rate, monthly average of daily closing bid yields, 1951-1964

Month	1951	1952	1953	1954	1955	1956	1957
January	1.34	1.57	1.96	1.18	1.23	2.41	3.11
February	1.36	1.54	1.97	.97	1.17	2.32	3.11
March	1.40	1.59	2.01	1.03	1.28	2.25	3.08
April	1.47	1.57	2.19	.96	1.59	2.60	3.06
May	1.55	1.67	2.16	.76	1.45	2.61	3.06
June	1.45	1.70	2.11	.64	1.41	2.49	3.29
July	1.56	1.81	2.04	.72	1.60	2.31	3.16
August	1.62	1.83	2.04	.92	1.90	2.60	3.37
September	1.63	1.71	1.79	1.01	2.07	2.84	3.53
October	1.54	1.74	1.38	.98	2.23	2.90	3.58
November	1.56	1.85	1.44	.93	2.25	2.99	3.29
December	1.73	2.09	1.60	1.14	2.54	3.21	3.04
	1958	1959	1960	1961	1962	1963	1964
January	2.44	2.82	4.35	2.24	2.72	2.91	3.52
February	1.54	2.72	3.96	2.42	2.73	2.92	3.53
March	1.30	2.80	3.31	2.39	2.72	2.89	3.54
April	1.13	2.95	3.23	2.29	2.73	2.90	3.47
May	.91	2.84	3.29	2.29	2.68	2.92	3.48
June	.83	3.21	2.46	2.33	2.73	2.99	3.48
July	.91	3.20	2.30	2.24	2.92	3.18	3.46
August	1.69	3.38	2.30	2.39	2.82	3.32	3.50
September	2.44	4.04	2.48	2.28	2.78	3.38	3.53
October	2.63	4.05	2.30	2.30	2.74	3.45	3.57
November	2.67	4.15	2.37	2.48	2.83	3.52	3.64
December	2.77	4.49	2.25	2.60	2.87	3.52	3.84

Source: Federal Reserve Bulletins, various monthly issues.

The time series of the 91-day open market Treasury bill rate will be broken down into the usual components; trend, cyclical, seasonal, and irregular--with descriptions of each of the components. Each component has been approximated by several techniques, and some discussion of the statistical methods employed will be provided.

Trend

A slight upward movement of the monthly bill rate over this period is discernible from Chart 1. The simple linear trend equation computed by least-squares for the period 1952 through 1964 is:

$$Y = 1.4633 + .0128\ T,$$

where $\underline{Y}$ indicates the bill rate and $\underline{T}$ indicates time in months beginning in January, 1952. The standard error of the estimate is only slightly less than the standard deviation specified above, indicating that the rate ranges widely about the computed linear trend; or, more specifically, it indicates that time is an unimportant variable in describing fluctuations in the bill rate. The linear trend indicates that for this period the bill rate increased, on average, slightly more than one hundreth of one per cent, or one basis point per month.

Three measures of the approximation of the trend-cycle were computed; a 12-month moving average, a 15-month weighted moving average using Spencerian constants, and a 21-month moving average using the appropriate Spencerian constants. In order to avoid losing observations from the process of computing the moving averages, the bill rate time series from January, 1948, to May, 1963, was smoothed resulting in only a few lost observations at the end of 1962. The 12-month and 15-month averages are subsequently used in attempting to estimate the seasonality; the 21-month average is used in describing the cyclical patterns of the bill rate.

Cyclical

The cyclical variations in the Treasury bill rate are apparent in Chart 1, and expressing the bill rate as a percentage of the computed linear trend show the same general pattern. Table 6 shows the bill rate as the percentage change from the previous month. Again the pattern is similar, but the percentage change values allow comparability of cyclical movements which are unaffected by the level of the rate. The largest percentage decrease was registered in February, 1958 (36.9 per cent) and the largest percentage increase was that for August, 1958 (85.7 per cent).

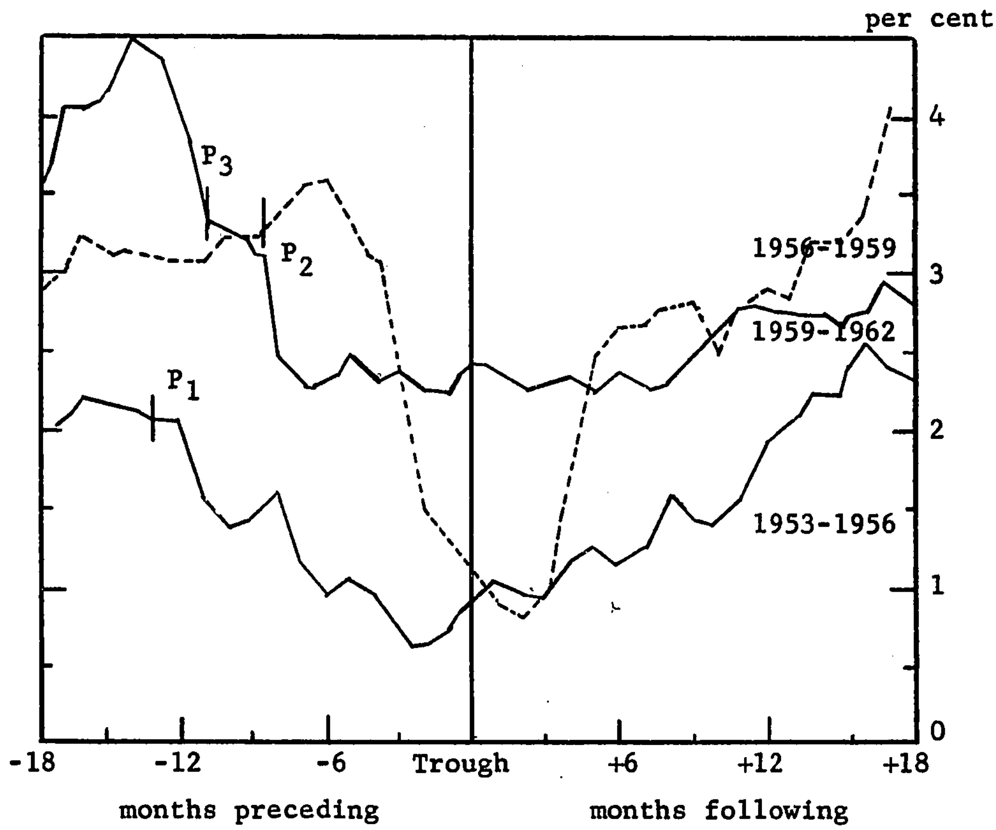
The original bill rate series can be divided conveniently into three almost equal periods which exhibit similar movements during the business cycles. These cyclical fluctuations conform generally with the cyclical movements in Gross National Product and other aggregate indicators of the cycle. The division into cyclical periods centered at the trough of the three recessions is presented and allows comparison of the movements of the monthly average of the outstanding bill rate in the cycles that occurred between 1953 and 1964. The time periods for the division are constructed in terms of the number of months preceding and months following a National Bureau of Economic Research reference cycle trough. Chart 2 shows the actual monthly average rates aligned at the reference cycle troughs.[80] The National Bureau of Economic Research cyclical peak dates are indicated. The time periods, in chronological order, are: (1) from February, 1953, to February, 1956, with the trough at August, 1954, (2) October, 1956, to October, 1959, with the trough at April, 1958, and (3) August, 1959, to August, 1962, with the trough at

[80]This type of illustration is provided in: "Interest Rates in the Current Cycle," Federal Reserve Bulletin (September, 1962), p. 1105.

TABLE 6.--Percentage change from the preceding month of the monthly average 91-day, open-market Treasury bill rate, 1953-1964

Month	1953	1954	1955	1956	1957	1958
January	- 6.2	-26.2	7.9	- 5.1	- 3.1	-19.7
February	.5	-17.8	- 4.9	- 3.7	0.0	-36.9
March	2.0	6.2	9.4	- 3.0	- 1.0	-15.6
April	9.0	- 6.8	24.2	15.6	- .6	-13.1
May	- 1.4	-20.8	- 8.8	.4	0.0	-19.5
June	- 2.3	-15.8	- 2.8	- 4.6	7.5	- 8.8
July	- 3.3	-12.5	13.5	- 7.2	- 4.0	9.6
August	0.0	27.8	18.8	-12.6	6.6	85.7
September	-12.3	9.8	8.9	9.2	4.7	44.4
October	-22.9	- 3.0	7.7	2.1	1.4	7.8
November	4.3	- 5.1	.9	3.1	- 8.1	1.5
December	11.1	22.6	12.9	7.4	- 7.6	3.7
	1959	**1960**	**1961**	**1962**	**1963**	**1964**
January	1.8	- 3.1	- .4	4.6	1.4	0.0
February	- 3.5	- 9.0	8.0	.4	.3	.3
March	2.9	-16.4	- 1.2	- .4	- 1.0	.3
April	5.4	- 2.4	- 4.2	.4	.3	- 2.0
May	- 3.7	1.9	0.0	- 1.8	.7	.3
June	13.0	-25.2	1.7	1.9	2.4	0.0
July	- .3	- 6.5	- 2.9	7.0	6.4	- .6
August	5.6	0.0	6.7	- 3.4	4.4	1.2
September	19.5	7.8	- 4.6	- 1.4	1.8	.9
October	.2	- 7.3	.9	- 1.4	2.1	1.1
November	2.5	3.0	7.8	3.3	2.0	2.0
December	8.2	- 5.1	4.8	1.4	0.0	5.5

Source: Computed by X-10 Version of Census Method II, as Table 19.



P_1 - cyclical peak, July, 1953; trough, August, 1954

P_2 - cyclical peak, July, 1957; trough, April, 1958

P_3 - cyclical peak, May, 1960; trough, February, 1961

Source: Table 5.

Chart 2.--Monthly average 91-day bill rates aligned at cyclical troughs for three cycles; 1953-1956, 1956-1959, and 1959-1962.

February, 1961. Seven months of data are excluded between (1) and (2), and there is a three month overlap between (2) and (3). At the beginning of the period 13 months are excluded, and at the end of the period four months are excluded prior to the end of 1962. From this chart it is apparent that the decline and recovery in the bill rate in the second cycle (1956-1959) was much sharper than the first and third cycle. Also the recovery of rates from the third cycle differs from the other two as rates recovered considerably more slowly from the trough date.

A problem reserved for the latter portion of this study will be an attempt to explain these cyclical movements through empirical tests of demand and supply hypotheses. At the present stage of analysis, however, the statistical description of rate movements turns to an examination of the shorter-term fluctuations that can be measured by seasonal adjustment techniques.

Seasonal

More effort has been devoted to describing the seasonal movements in the 91-day bill rate than was expended in determining the general trend and cyclical movements. Since the purpose of this study is to attempt to explain the movements of the Treasury bill rate over time using short time periods, the seasonal description is more valuable for analysis of the short-term movements than the trend or the cycle.[81] The seasonal indexes have proven difficult to isolate to a very satisfactory degree because of the large irregular movements in the bill rate series. Seasonal adjustment techniques are also used in isolating within-month variations in the

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[81] Nevertheless, the estimation of the trend-cycle is extremely important in obtaining appropriate measures of the seasonal influences.

bill rate. Additional information is gained on the timing, direction, and magnitude of short-term movements in the bill rate by isolating weekly seasonal adjustment factors.

The short-term fluctuations, which will be referred to as seasonal movements due to their assumed periodicity, are considered to be caused by seasonal movements in the demand for and stock of bills. Specifically, the seasonal indexes that are isolated in the following attempts are assumed to be due to institutional factors, namely, the periodic recurrent actions (which may at times be offsetting or in the same direction) of the Treasury, Federal Reserve System, commercial banks, nonfinancial corporations, state and local governments, dealers, and foreign holders. It is assumed further that the seasonality of the bill rate is the result of weighted seasonal demand and supply preferences of these institutional participants. The latter part of this study will be concerned with empirical verification of some of these assumptions.

The majority of the following description of the seasonality of the bill rate will concentrate on monthly seasonal influences. The weekly factors which are important will be discussed separately and compared with the general conclusions drawn from monthly adjustments.

Several methods were used in the attempt to measure the seasonality of the bill rate. Many of these methods were unsuccessful because of some very sharp irregular movements.

The ratio-to-12-month-moving-average method

This technique was employed to estimate the specific seasonal indexes for several different time periods. Due to wide variation in the individual monthly ratios, the specific seasonals were calculated by the same method over different time periods to arrive at monthly adjustment factors that were not unduly large or small. The great amplitude of the bill rate in the period from late 1957 to mid-1960 affects the value of the positional means since the larger ratios become more important with shorter time periods. Conversely, the stable, low level of rates that existed in the period 1948-1951, causes the positional means to tend toward lower values.

The results of the application of the ratio-to-12-month-moving-average in three different periods are shown in Table 7. The specific indexes computed for the periods 1952-1962 and 1951-1965 are subject to the effect of the extreme ratios of the 1957-1960 period, while the more stable ratios for the period 1960-1965 indicate either a lessening of seasonal movements from earlier periods or biases in estimating the seasonal factors in the earlier periods.

The results of the ratio-to-12-month-moving-average specific seasonals for the period 1952-1962 will be used as a rough guide for evaluating the direction and size of the adjustment factors computed by other techniques. The specific seasonals for this period correspond favorably with the preliminary results of the adjustments done by William H. Brown, Jr., who reported:

> The normal seasonal pattern in bill yields indicates a falling off from a seasonal high in December to a temporary low in March, followed by a rise in April and May, and then a fall to a low in July. Rates then rise to a temporary high in September and fall back somewhat before reaching their peak in December.[82]

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[82] William H. Brown, Jr., "Seasonal Variations in Interest Rates," Tested Knowledge of Business Cycles, 42nd Annual Report of the National Bureau of Economic Research, 1962, p. 82.

TABLE 7.--Stable seasonal factors for the average monthly discount rate on 91-day U. S. Treasury bills

Month	"Specific Seasonals" for the Series		
	1952-1962[a]	1951-1965[b]	1960-1965[b]
January	104.4	102.5	101.4
February	99.1	98.8	102.8
March	96.1	96.7	101.4
April	98.7	99.1	99.2
May	96.6	95.8	98.0
June	96.5	94.2	98.1
July	91.6	95.0	99.1
August	98.3	101.0	99.8
September	105.0	103.3	99.9
October	100.0	102.8	98.0
November	101.9	103.1	100.9
December	111.8	107.2	101.3

[a]Calculated by positional mean of the ratio-to-moving-average.

[b]Calculated as Table 10A by X-10 version of Census Method II.

Source: The original rates that were adjusted were taken from the table "Money Market Rates," Federal Reserve Bulletin.

As yet, there has been no officially published seasonally adjusted measures of the Treasury bill rate.[83] Nevertheless, market reports from the Federal Reserve Board of Governors and Federal Reserve Banks indicate that some measure of bill rate seasonality is present. In a recent Staff Paper in the Federal Reserve Bulletin, it was noted that

[83]With the exception of Brown's work, the only other evidence of seasonal adjustment of any United States Government securities rates, are reports by Government securities dealers in their market surveys.

"...there has been a marked change since 1960 in the seasonal behavior of rates on 3-month Treasury bills."[84] Brown's seasonal adjustment of several term-to-maturity bill yields, also indicates a changing seasonal influence.[85]

Since the seasonality of bill yields is possibly changing over time, attempts were made to measure the seasonal indexes by techniques providing moving adjustment factors instead of the rigid factors obtained from the ratio-to-moving-average method.

Wald's method of seasonal adjustment[86]

This method, measuring seasonality as an additive factor instead of the multiplicative form of the ratio-to-moving-average method, was computed for the monthly bill rate for the period 1952-1962. With the exception of the first and last years, the seasonal indexes from Wald's method were in the direction indicated by the ratio-to-moving-average specific seasonal indexes. However, the magnitude of the adjustments were greatly exaggerated in 1954, 1958, and 1959, which were years in which the bill rate was characterized by very sharp and sudden changes. The lack of success of this method was probably due partially to the large irregular movements of the rate, but it also seems likely that the assumption of an additive seasonal adjustment is inappropriate in the case of the Treasury

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[84] Frank R. Garfield, "Economic Change and Economic Analysis," Federal Reserve Bulletin, Vol. 49 (September, 1963), No. 9, p. 1210.

[85] Brown, op. cit., p. 80.

[86] Wald's method of adjustment is described in: Robert Ferber and P. J. Verdoon, Research Methods in Economics and Business (New York: The Macmillan Company, 1962), pp. 328-331; and Gerhard Tintner, Econometrics (New York: John Wiley and Son, 1952), pp. 227-233.

bill rate. Brown also attempted an additive adjustment of the bill rate, but concluded that: "because the size of the additive adjustment seems to be too large when rates are cyclically low, amounting almost to a third of the total yield of Treasury bills, it was decided that the multiplicative adjustment was preferable."[87]

The failure of the additive adjustment indicates the need to use a technique for adjustment that yields multiplicative indexes, but with moving seasonal factors instead of rigid ones.

<u>The Bureau of the Census Method II</u>

The seasonal factors calculated by this method agreed in direction and average magnitude with the earlier attempts.[88] However, when the seasonal adjustment factors were examined over time for each month, it was found that the factors for 10 of the 12 months moved from near 100 at the beginning of the period to a peak or a trough in 1958, then back at the end of the period to near 100 again. The largest movement of a seasonal factor over the period 1952-1962 was for the month of October with the adjustment factor moving from 95 in 1952, to 116 in 1958, then back to 99 in 1961. The adjustment factors for the same dates for the month of July were 101, 81, and 94. This movement seems too extreme to be considered moving seasonality, and most probably is due to the successive smoothing

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[87] Brown, <u>op</u>. <u>cit</u>.

[88] The version utilized was a simplified version written by Milo Peterson, and available as a library program from IBM. The program description closely follows the procedure outlined in: Julius Shiskin and Harry Eisenpress, <u>Seasonal Adjustments by Electronic Computer Methods</u>, Technical Paper 12 (New York: National Bureau of Economic Research, Inc., 1958).

of the irregular variation.[89] Although the indicated direction of the seasonal factors were generally the same as the specific seasonals of the ratio-to-moving-average method, it seems very unlikely that the adjustment factors computed by this program adequately reflect the moving seasonality.

The linear regression method of seasonal adjustment. This approach, developed by the Deutsche Bundesbank, was investigated as a possibility in attempting to measure the changing seasonal pattern.[90] This method yields indexes that may be additive, multiplicative, or simultaneously additive and multiplicative.[91]

Basically the regression technique allows the original observation to be the dependent variable (Y), and the 12-month-moving-average

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[89]Shiskin has cautioned that Census Method II gives results that are unsatisfactory if there are sharp movements in the data, and that particular care is necessary in the interpretation of the indexes near the sharp changes and at the beginning and end of the period adjusted. See: Julius Shiskin, "Statistics for Short-Term Economic Forecasting," Business Cycle Indicators, Volume I, (Ed.) Geoffrey H. Moore (Princeton: Princeton University Press, 1961), p. 602; also, "A Technical Note on the Seasonal Adjustment of Highly Irregular Series by Univac Method II," (Department of Trade and Commerce, Ottawa, Canada, 1959) mimeographed.

[90]Application of the Regression Method to the Analysis of Statistical Time Series (1959); The Practice of Seasonal Adjustment with Regression Equations (1960), by the Deutsche Bundesbank, Frankfurt (Main). Also, "Experience in the Application of Regression Computing to the Seasonal Adjustment of Statistical Time-Serice," Reprint from: Monthly Reports of the Deutsche Bundesbank, Vol. 13, No. 8, August 1961, pp. 19-24; and Julius Shiskin, "Electronic Computer Seasonal Adjustments: Test and Revisions of U. S. Census Methods," Seasonal Adjustment on Electronic Computers (Organisation for Economic Co-Operation and Development, 1961), pp. 94-95 and 130-138.

[91]A comment here seems relevant; "Sometimes the additive and multiplicative hypotheses are combined in the same model, though this seems hard to justify from a logical standpoint." J. Durbin, "Trend Elimination for the Purpose of Estimating Seasonal and Periodic Components of Time Series," Proceedings of the Symposium on Time Series Analysis, (Ed.) Murray Rosenblatt (New York: John Wiley and Sons, Inc., 1963), p. 3.

values of the Y's the independent variable (X). A linear correlation for each month (with the number of paired X, Y values depending on the number of years for which moving average data are available) is computed in the form:

$$\hat{Y} = a + bX.$$

The seasonally adjusted series (S) is obtained through:

$$S = \frac{Y - a}{b}.$$

For the moving index, time (t) is included in the formula in the form of:

$$\hat{Y} = a + bX + ct + dXt,$$

with the adjusted series being computed from:

$$S = \frac{Y - a - ct}{b + dXt}.$$

Several attempts were made using this method, with the independent variable (X) being in turn the 12-month-moving-average, the 15-point Spencerian constant, and the 21-point Spencerian constant. Each formulation was computed both with and without time as a variable.

The results of these attempts were generally in the same direction as the specific seasonals computed by the ratio-to-moving-average method. However, when time was included as a variable, none of the estimates for "c" and "d" was statistically significant.

Without time as an independent variable, seasonal adjustments by this method yield stable adjustment factors. The result of these attempts showed "mixed" seasonal factors with the "a" and "b" values adjusting the original values (Y) in opposite directions,[92] indicating a possibility of

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[92]"Mixed" adjustment factors occur when $a < 0$ and $b > 1$, or when $a > 0$ and $b < 1$, with the relative magnitudes of the "a" and "b" values determining whether any particular adjustment will result in an increase

a combination of additive and multiplicative adjustments. However, when the extreme ratios were excluded from the regressions, the "a" values moved nearer to a value of zero, reaffirming the earlier suspicion that the additive adjustment was inappropriate with this series. Although the exclusion of the extreme ratios brought "a" nearer to a zero value, the final adjustment was changed only slightly yielding seasonally adjusted series which correspond closely with the ratio-to-moving-average specific seasonally adjusted series. The hope that this method would produce a reasonable measure for moving seasonality was not fulfilled.

The X-10 Version of the Census Method II, which has only recently been developed,[93] generally yields results more conservative than the original Census Method II, and seems to give better adjustment to highly volatile series. This approach selects a "best" moving average as the basis for calculating the seasonal adjustment factors. Many of the deficiencies noted above in the seasonal adjustment by the original Census Method II do not seem to apply to the results of the X-10 version.

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or a decrease in an original observation. The general situation with this type of adjustment is to make a smaller percentage adjustment of small original values of the series, and a larger percentage adjustment of larger original values. Since these adjustments are not the same for all values in a particular month, it appears that the adjustment factors are "moving." The indexes, nevertheless, are rigid and similar to the adjustment that would be obtained with the ratio-to-moving-average specific seasonal indexes.

[93] Stephen N. Marris, "The Treatment of Moving Seasonality in Census Method II," Seasonal Adjustment on Electronic Computers, op. cit., pp. 257-309. Although this article was the basis for the X-10 revision, several other changes were made during the experimental stages. A description of the differences between this program and the original Census Method II are described in "Specifications for the X-10 Version of the Census Method II Seasonal Adjustment Program," Bureau of the Census, Office of the Chief Statistician, April 19, 1963, mimeographed.

The results obtained by this method seemed to be quite reasonable as moving seasonal factors. Nevertheless, there is some indication of the "U" shaped or "humped" pattern when the final adjustment factors of each month are separately viewed over time. February, March, and July are examples of the "U" shaped movement; April, October, and December show "humped" patterns. The extremes of the adjustment factors from the X-10 version of Census Method II are much smaller than those from the original Census Method II. The widest variation calculated was for the month of October with the final adjustment factors moving from 99.6 in 1952 to a peak of 107.7 in 1957, then back to a low of 99.5 in 1964. This movement of plus 8.1 and minus 8.2 points seems more reasonable as "moving seasonality" than the 20 point movement for October's factors calculated by the original Method II.

The final monthly seasonal adjustment factors calculated by the X-10 version are shown in Table 8. This table is designed to facilitate the comparison of the movement of the seasonal factors for each month over several years. This adjustment by the X-10 revision provides an adjustment factor that is not subject to the extreme "humped" and "U" shaped patterns of Method II discussed above.[94] An interesting conclusion from Table 8 is that generally the degree of seasonality in the bill rate seems to have lessened since around 1961.[95] Using the range between the

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[94]The statements regarding the "reasonableness" or "goodness" of a set of adjustment factors are clearly subjective. Some interesting attempts to appraise seasonality on a more scientific basis are discussed below in the text.

[95]This result may be compared to Garfield's statement above (footnote 84); and Brown's statement that "There are a number of reasons to believe that the seasonal on short-term securities was reduced in 1961

TABLE 8.--Moving monthly seasonal factors for the average monthly bill rate (daily average of closing bid yields), computed by the X-10 Version of Census Method II, 1952-1964

Year	January	February	March	April	May	June
1952	99.4	95.1	95.8	99.4	99.0	95.0
1953	100.4	94.8	95.7	99.5	98.2	95.0
1954	101.3	94.9	95.6	99.4	97.3	94.7
1955	102.4	95.3	95.3	99.4	96.1	94.6
1956	102.9	96.1	95.0	99.2	94.7	94.4
1957	103.5	97.2	94.9	99.1	93.7	94.2
1958	103.8	98.7	95.2	99.0	92.9	94.2
1959	104.1	100.1	95.8	99.1	92.6	94.2
1960	104.1	101.3	96.7	99.1	92.9	94.2
1961	104.0	102.1	97.5	99.0	94.0	94.4
1962	103.7	102.8	98.4	98.7	95.0	94.8
1963	103.5	103.0	99.1	98.4	96.2	95.3
1964	103.0	102.8	100.0	98.3	97.0	95.5

Year	July	August	September	October	November	December
1952	99.5	104.5	103.3	99.6	100.3	109.4
1953	97.4	104.0	103.8	101.3	101.2	109.2
1954	95.1	103.2	104.3	103.3	102.4	108.8
1955	92.7	102.3	104.8	105.5	103.8	108.3
1956	91.4	101.4	1.051	107.1	104.8	107.7
1957	90.6	100.6	105.0	107.7	105.5	107.2
1958	91.0	99.8	104.4	106.9	105.7	106.8
1959	91.9	99.1	103.7	105.5	105.5	106.5
1960	93.6	98.8	102.9	103.3	104.7	106.1
1961	95.1	98.7	102.3	101.3	103.7	105.8
1962	96.5	98.7	101.6	99.9	102.9	105.5
1963	97.6	98.7	100.8	99.5	102.1	105.1
1964	98.4	98.8	100.2	99.5	101.6	104.8

Source: Computed as Table 12 of the X-10 Version of Census Method II from the series January, 1951 through June, 1965.

highest and lowest seasonal factors in each year as a guide to the degree of seasonality, there was a steady increase from 14.4 points in 1952 up to 16.3 points in 1956, then a steady decrease to 9.3 points in 1964.

In summarizing this lengthy discussion of monthly seasonality, several important qualifications should be made regarding the different approaches used in attempting to isolate the seasonal factors. First, the methods used were all purely empirical, and as such, provide little basis for using inference statements regarding the validity of any particular method of adjustment. As yet, the tools necessary to perform inferential calculations are not fully developed, and have not come into general usage.[96] The newer techniques of multiple regression using dummy variables and spectral analysis are coming into wider usage, and show promise of providing methods of measuring the characteristics of time-series from a theoretically tenable basis.[97] These approaches avoid the

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but not completely eliminated. It was largely eliminated in 1962. Two reasons confirm our previous thinking on the cause of the seasonal: (1) There was a substantial reduction in the variation of the supply of bills made available to the public by the federal government in 1962 and some reduction in 1961. (2) In 1962 the variation during the year in net cash borrowing from the public was considerably smaller than it had been recently." Brown, op. cit., p. 80.

[96] John A. Brittain, "A Bias in the Seasonally Adjusted Unemployment Series and a Suggested Alternative," Review of Economics and Statistics, XLI (November, 1959), No. 4, pp. 405-411; and, John A. Brittain, "A Regression Model for Estimation of the Seasonal Component in Unemployment and Other Volatile Time Series," Review of Economics and Statistics, XLIV (February, 1962), No. 1, pp. 24-36.

[97] For discussion and examples of utilizing dummy variables in multiple regressions for measurement of seasonality, see: Michael C. Lovell, "Seasonal Adjustment of Economic Time Series and Multiple Regression Analysis," Journal of the American Statistical Association, 58, (December, 1963), No. 304, pp. 993-1010; Ferber and Verdoon, op. cit.; and, A. James Meigs, Free Reserves and the Money Supply (Chicago: The University of Chicago Press, 1963), pp. 75-80. On spectral analysis, see: C. W. J. Granger, Spectral Analysis of Economic Time Series (Princeton: Princeton University Press, 1964).

moving-average measurement of the trend-cycle, and consequently avoid the problems encountered in adjusting a series as volatile as the Treasury bill rate. All of the methods described in this chapter utilize the moving-average as the basis of the trend-cycle measurement.[98] Most of the difficulties encountered in measuring the seasonality of the bill rate were due primarily to the inadequacy of the moving-average in explaining the trend-cycle.

Another important qualification which should be re-emphasized is that the monthly series which has been used for the original data is an average of daily closing rates of thirteen different bill maturities. The results might have been different if a yield of a single bill maturity on a single trading day of each month had been used.[99] In order to investigate this possibility, weekly seasonality of the average yield on new 91-day bills in the weekly Treasury auction was measured.

Weekly Seasonality

Given the volume of trading in the United States Treasury bill market, and the size of individual transactions, it seems logical to assume that an intra-monthly seasonal pattern may exist independently of the monthly pattern. In fact, the monthly pattern may simply reflect an average of a "real" seasonal movement which is weekly. Any bill maturity could be used in investigating the intra-monthly patterns, but there are

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[98]Several attempts were made using dummy variables in multiple regression equations for measuring the seasonality of the bill rate. Due to problems of formulating proper relationships, all attempts proved unsuccessful.

[99]Brown has seasonally adjusted a thrity-day to maturity bill rate (1952-1961), and a fifty-five-day to maturity bill rate (1954-1961) on a weekly basis; as well as the 91-day bill rate on a weekly and monthly basis (1948-1961).

several advantages in using the rate on new 91-day bills established in the weekly auction.

The means of the accepted bids in the weekly bill auctions provide the basis for this weekly bill rate series. The Monday deadline for submitting bids is assumed to be the date that this rate is established. This is the Monday following the announcement of the tender of the previous Wednesday, and preceding issue on the following Thursday. The source of these rates is the Annual Report of the Secretary of the Treasury on the State of the Finances for the relevant years. The time period is from January 1952 through December 1964.

The technique used here for weekly seasonal adjustment involves dividing the series into four separate series, one series for each of the four weeks; and adjusting each of the four series separately by the same methods employed for adjusting monthly data. This method is described by Shiskin:

> To seasonally adjust weekly series by the electronic computer program prepared for monthly series, each weekly series is divided into four separate series, one comprising the first weeks of each month, another the second weeks of each month, and so on. Each of these four series is then run through the monthly census seasonal program and the results are rearranged chronologically into a continuous weekly seasonally adjusted series. Data for the four missing weeks of each year are obtained by averaging seasonal factors for the preceding and following weeks.[100]

This technique raises some conceptual problems. One of the most important is in interpreting the meaning of the weekly adjustment factors.

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[100] Julius Shiskin, "Statistics for Short-Term Economic Forecasting," Business Cycle Indicators, Vol. 1, (Ed.) Geoffrey H. Moore, (Princeton: Princeton University Press, 1961), pp. 602 and 604. On intra-monthly series, see also: M. J. Conlon, "Intramonthly Series in Economic Forecasting," American Statistical Association, 1960 Proceedings of the Business and Economic Statistics Section, pp. 36-43.

The adjustment factor for a first week of a particular month has relevance only to the first weeks of the preceding and following months. For instance, if the original values of the first week were always lower than the original values for the second week, this would not be reflected in the rearranged seasonal factors. The weekly seasonal adjustment factor for the first week in January is measured against the first week only of other months, and is not statistically related to any values of the second, third, or fourth weeks. Another comment which should be kept in mind is that the value for the first Monday in each month can be for any day from the first day of the month to the seventh day of the month. The vagaries of the calendar are particularly frustrating when attempting to measure weekly seasonality. Conlon has experimented with 10-day intervals in measuring intra-monthly seasonality, but that would complicate the problem in this particular circumstance since the 10-day intervals would bring about a variation in the maturity length of the bills.[101]

The X-10 Version of Census Method II was used to calculate the weekly seasonal adjustment factors. Since this method of adjustment seemed workable with monthly data, and since the movement of each of the weekly series generally resembles the movement of the monthly series, the results should be as good. The weekly series adjusted here was from January, 1952 through June, 1965.

The important comparison of the seasonal factors are among the seasonals for the four different weekly series and the relationship to the monthly factor. It seems apparent that differences exist between the seasonal factors for various weeks of the same month. Although this

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[101] Conlon, *op. cit.*

conclusion has been qualified above, there seems to be a definite weekly pattern to the 91-day bill rate. Brown has pointed out that:

> While most of the series were adjusted on both a monthly and weekly basis, it became apparent that the weekly adjustment gives a much better picture of the actual seasonal movement. For example, during August there is a definite rise in the weekly seasonal factors for Treasury bills, ...whereas the monthly adjustment indicates no significate seasonal in that month.[102]

Reading from Brown's chart, it appears that the weekly seasonal factors for August, 1960, increase from about 88 at the beginning of the month to possibly 105 by the end of the month. Although the numerical results presented in Chart 3 and Chart 4 do not correspond exactly with Brown's, they lead to the same general conclusion.[103]

Chart 3 illustrates the weekly seasonal factors after rearrangement in chronological order after the four separate weekly adjustments, and the original and seasonally adjusted rates for the year 1960. As further illustration of weekly seasonality of the bill rate, Chart 4 shows the seasonal factors for the years 1956, 1960 and 1963. Evidence of moving seasonality is apparent by a comparison of these seasonally adjustment factors, with the degree of seasonality decreasing.

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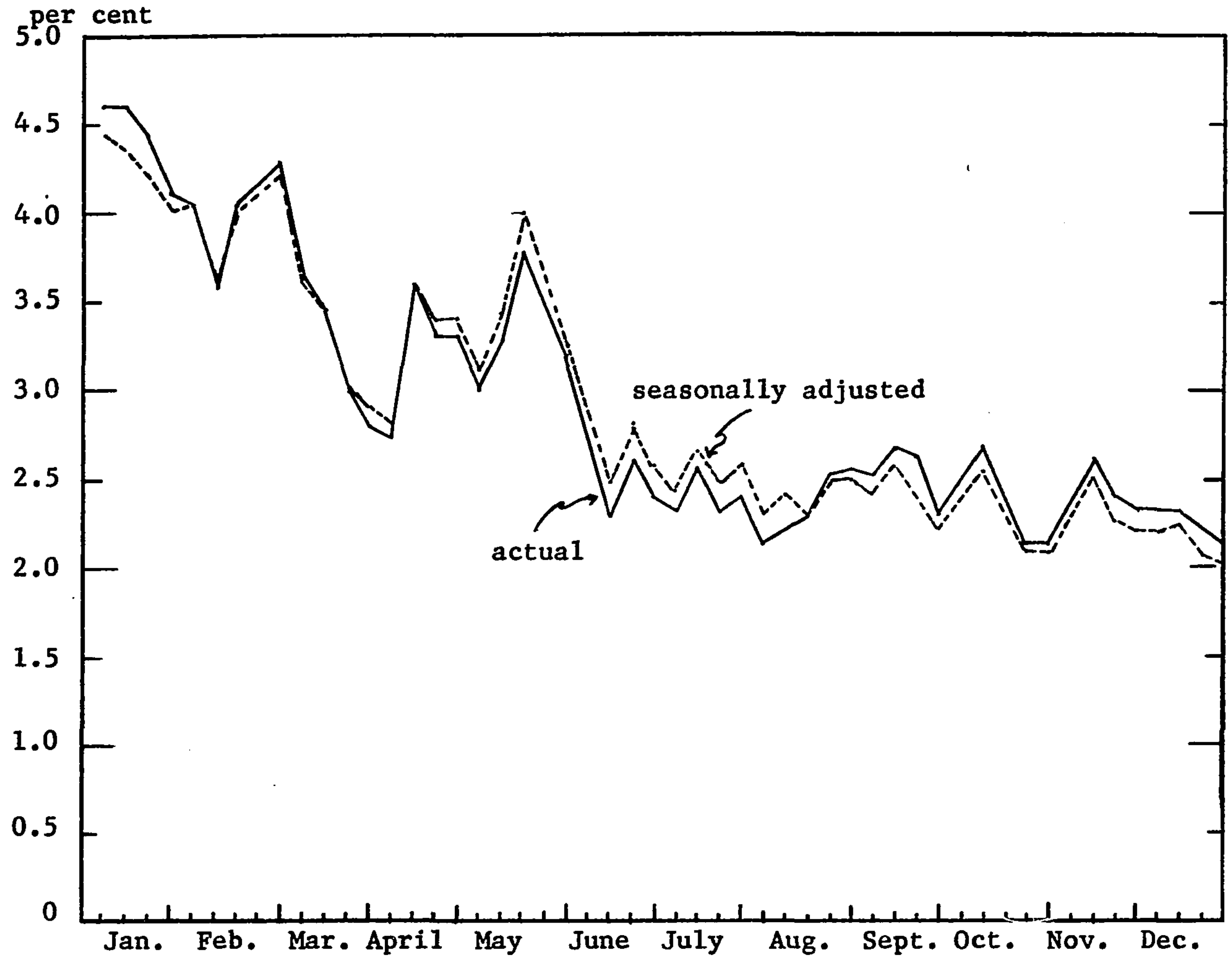
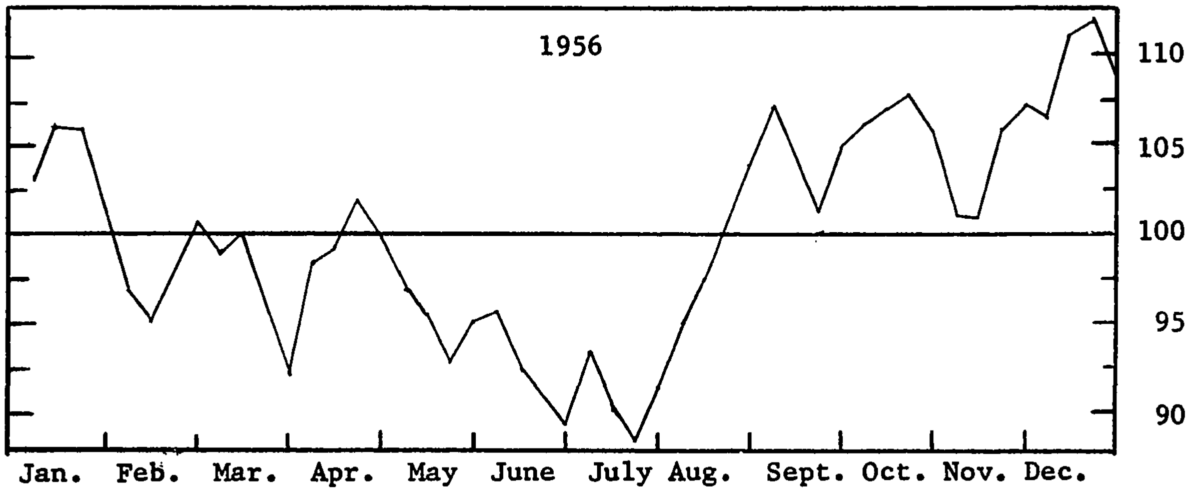
[102] Brown, op. cit., p. 80. Brown has assisted very generously in the attempts to measure the seasonality of the bill rate by making his preliminary adjustments available to me. His source for the 91-day bill rate was the Federal Reserve Bulletin which differs occasionally from the Treasury source, but seldom by more than .001 per cent. In some cases, we differ in determining which rate should be listed as the appropriate rate for the first week in a month. The procedure here was to subtract three days from the Thursday issue date to arrive at Monday's rate. The rates in the Federal Reserve Bulletin are Saturday (end of week) rates, requiring a subtraction of five days.

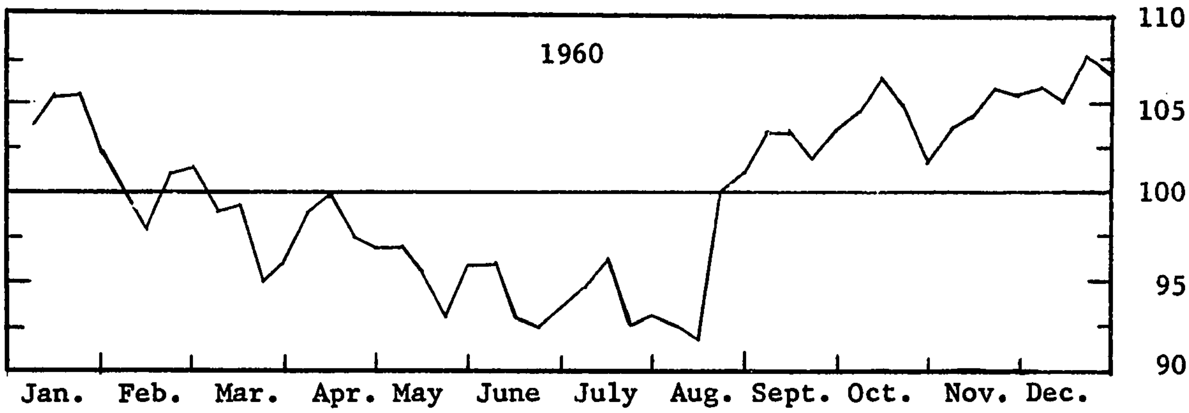
[103] The computed seasonal factors are chronologically 92.7, 91.8, 100.1, and 101.1; the monthly seasonal factor for August computed as Table 10A of the X-10 Version (Stable Seasonal Factors) was 101.0.

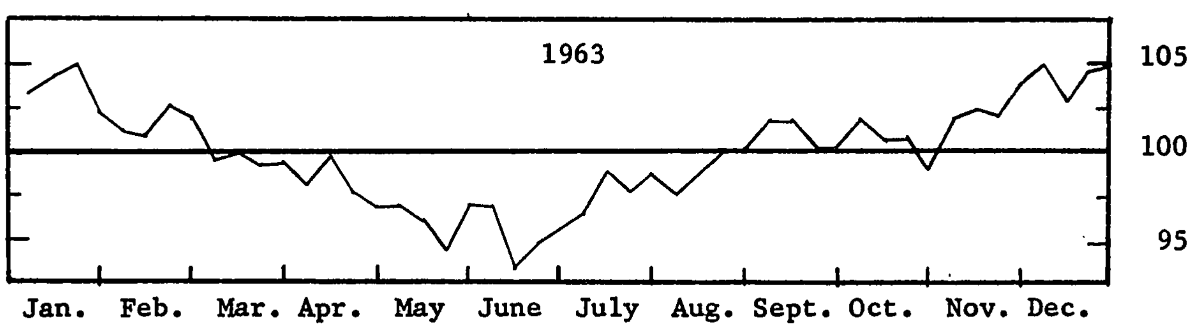


Source: Treasury Bulletin, and calculated by X-10 Version of Census Method II.

Chart 3.--Original and seasonally adjusted 91-day open market bill rates, weekly, 1960.







Source: Calculated by X-10 Version Census Method II. (Fifth weeks in months have been excluded in order to show direct comparability.)

Chart 4.--Weekly seasonal factors for the years 1956, 1960, and 1963.

The general conclusion from the attempt to compute weekly adjustment factors is that, although the weekly patterns are similar to each other (as well as similar to the monthly seasonal factors), a fully satisfactory explanation of the movement of the Treasury bill rate would require explanation of the intra-monthly movements. Methodologically, this becomes very difficult, particularly because of the autocorrelation resulting from extremely short time period. Because of the lack of weekly ownership data, transactions volume, and other important independent variables, the estimation becomes statistically impossible.

Irregular

Quantitatively, the irregular movements in the Treasury bill rate are more important than the seasonal movements. The X-10 Version of Census Method II computes the irregular factor by dividing the seasonally adjusted series by the weighted 15-month-moving-average of the adjusted series. The irregular factor is therefore the residual after seasonality is removed from the original rates, and the trend-cycle is removed from the seasonally adjusted series.

It should not be inferred that the irregular factor is equivalent with exogenous movements, or that what is measured in necessarily unexplainable by statistical methods. The irregular factor measures that portion of the series that has not been ascribed to seasonality and the trend-cycle. In the empirical analysis of the later chapters, an attempt is made to explain all movements in the bill rate including the irregular movements by least-squares methods.

In Table 9 the computed irregular factors are given for the period 1952-1964. The irregular factors for each week have also been computed, but since they are similar to the monthly series they have not been shown separately.

TABLE 9.--Irregular components for the average monthly market 91-day bill rate, 1952-1964

Year	January	February	March	April	May	June
1952	99.4	100.6	101.8	94.6	99.4	103.5
1953	98.5	101.0	98.1	100.5	100.5	103.3
1954	96.7	92.7	109.1	107.8	94.0	85.0
1955	103.4	97.6	98.5	110.3	98.7	92.0
1956	99.2	99.2	94.8	102.3	106.2	101.1
1957	98.7	102.6	101.9	94.8	98.2	102.9
1958	104.9	86.7	97.9	101.8	98.0	82.2
1959	99.3	97.1	101.0	99.0	97.5	103.6
1960	104.5	101.3	94.0	96.7	114.6	92.2
1961	95.6	103.5	104.3	96.7	101.2	102.9
1962	102.3	100.4	100.7	98.6	98.6	100.0
1963	101.1	100.0	100.7	99.3	99.3	99.7
1964	99.4	98.8	101.1	99.7	100.8	102.0
	July	August	September	October	November	December
1952	104.6	100.0	94.3	98.3	100.5	100.5
1953	102.0	103.2	99.4	86.6	99.3	112.2
1954	95.0	107.2	110.2	102.2	91.0	98.1
1955	100.6	101.1	100.5	101.0	99.1	103.1
1956	96.6	97.0	100.7	98.5	100.4	101.4
1957	101.5	97.1	99.1	102.2	103.7	106.8
1958	76.3	103.0	117.0	107.0	100.4	98.1
1959	100.9	94.5	103.4	98.0	97.8	103.9
1960	94.6	96.3	104.8	100.0	102.7	95.9
1961	99.2	103.4	95.7	97.0	100.0	99.6
1962	105.2	100.4	97.5	98.9	100.0	98.6
1963	100.6	101.2	99.1	101.8	100.9	97.7
1964	98.9	99.7	99.2	100.6	99.2	99.7

Source: Computed as Table 23 of X-10 Version of Census Method II.

Summary and Conclusions

The simple linear trend of the average monthly bill rate has been slightly upward over the period 1953-1964. The trend by itself however, explains very little of the movement in the bill rate.

The bill rate has fluctuated quite widely, and is subject to very sharp movements. Although the rates move in similar fashion during business cycles, the degree of the movement seems dependent on the severity of the cycle.

The extreme fluctuation in the bill rate during 1958 made the description of the seasonality particularly difficult. Several methods were attempted before a reasonable measure of seasonality was obtained by using the X-10 Version of Census Method II. The results of measuring seasonality showed definitely that a monthly seasonal pattern existed, and that this pattern was a changing one over time. A weekly measure of seasonality was obtained showing that intra-monthly variations in the Treasury bill rate were quite important, and seemingly partially explanatory of the monthly seasonal patterns.

This Chapter has been basically descriptive rather than analytical. Very little has been said in regard to the causes of the movements in the bill rate series, as the purpose of this Chapter has been to isolate and measure the trend, cyclical, seasonal, and irregular fluctuations. These measurements will provide the basis for attempting to assign causes to bill rate movements.

Chapter IV is basically descriptive also. It compared the fluctuations in the bill rate with fluctuations in other maturities of United States government securities.

CHAPTER IV

THE RELATIONSHIPS OF THE MOVEMENTS OF THE TREASURY BILL RATE AND INTEREST RATES OF OTHER SECURITIES

Introduction

The rate of interest is normally treated as an important variable in macroeconomic general-equilibrium analysis. In these theoretical systems, some variation of the liquidity-preference theory or the loanable-funds theory provides the basis for explaining the determination of *the* rate of interest.

The rate of interest is usually viewed as some average interest rate of selected securities, or as the rate on a single security which is regarded as "representative." The rationale for including this single rate, as opposed to several rates or a structure of rates, is that the movements of various rates are highly correlated, moving in the same direction at approximately the same time. This study attempts to analyze the factors determining the rate on one particular security, Treasury bills, in a microeconomic, partial-equilibrium framework. If the bill rate is not strongly affected by macroeconomic movements, and in turn has little effect on the movements of other relevant variables, the partial-equilibrium approach would seem legitimate. If, on the other hand, the interrelationships among the bill rate and macroeconomic variables have quite strong interdependence, a general-equilibrium approach would be necessary in analyzing the determinants of the bill rate.[104] A principal purpose of this study is to evaluate the usefulness of the partial-equilibrium analysis of bill rate determination.

By taking a partial-equilibrium approach, the problems of having to choose between liquidity-preference of a loanable-funds theory, and whether to view supply and demand of securities or the demand and supply of money, are largely avoided. The partial-equilibrium approach necessarily imposes a very general and sweeping *ceteris paribus* assumption. Many very important and established economic relationships will be treated lightly or not at all. For instance, the yield on capital, and hence most aspects of non-monetary interest rate theories, will not be considered.

The implications of this approach are extremely important to the validity of this study. It is necessary therefore to examine very carefully the relationship between the bill rate and some other rates on "substitutable" securities.

The Relationship between the Bill Rate and Rates on "Substitutable" Securities

A glance at the Federal Reserve System publication *Historical Chart Book* illustrates the similarity in the patterns of rate movement over time of the various monthly Governmental and corporate issues. Generally the long-term Federal government bonds yield higher market rates than shorter-term Federal government obligations, and corporate bonds yield higher rates than long-term Federal government bonds.

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[104] Richard G. Lipsey, *An Introduction to Positive Economics* (London: Weidenfeld and Nicolson, 1963), pp. 129-134, and Assar Lindbeck, *A Study in Monetary Analysis* (Stockholm: Almquist and Wiksell, 1963), especially Chapter 1.

The factor principally responsible for the rate differentials on corporate and government securities is risk. There is absolutely no risk of default of principal with Federal obligations. With corporate bonds, the risk of default often is slightly greater (depending on the corporation), but this uncertainty is considered a factor in market yield differentials. Longer-term Federal government securities generally show higher market interest yields than shorter-term Federal government securities and the reasons might well be described under the general heading of risk.[105] Although there is no risk of capital loss with government securities, other types of risk are present. Types of risk in holding government securities have been conveniently categorized by Tobin. First, "All categories of government debt, including demand debt, share their principal risk, namely uncertainty about purchasing power of the dollar."[106] Since the risk is shared by all government securities, this is not a basis for rate differentials. "The second risk of governmental obligations is due to uncertainty about future interest rates. This risk affects differently obligations of different maturities."[107] Tobin elaborates on the second type of risk by viewing separately effects on holders with short horizons and long horizons. For the holder of short horizon the certainty of the maturity value would naturally make shorter-term securities less risky than longer-term securities. For the holder of long

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[105] State government Aaa securities have market yields below long-term Federal government securities, but another feature blurs this relationship; that is the tax-exempt feature of some state obligations. Other features such as rights near maturity, callable versus non-callable, and restricted ownership are not considered here.

[106] Tobin, _op_. _cit_., p. 163.

[107] _Ibid_., p. 164.

horizon the risk of maturities is reversed. Tobin points out that if interest rates generally move together, Government securities of different maturities are substitutes in portfolios of both investors of short and long horizon. Also:

> There is a third situation, in which the target date is neither at the beginning nor at the end of the maturity spectrum. Maturities both longer and shorter than the horizon entail risk, the more risk the more they diverge from the target date. But longer and shorter maturities can be combined as an imperfect hedge; and in this situation they are complements, rather than substitutes.[108]

Several possible reasons for long-term rates to exceed short-term rates may be suggested on the basis of Tobin's comments. First, the long-term rates may be dependent only on the expectations of the future course of short-term rates. Second, given the relative quantities of various maturities to hold, there may be a relatively greater demand to hold the short-term obligations because portfolios of holders with short horizons exceed portfolios of holders with long horizons. Third, given a degree of uncertainty as to the target date, holders may prefer to "underestimate" rather than "overestimate" the date, because of the greater change in price of long-term securities than short-term for any interest rate change, giving rise to a liquidity premium with rate differentials between short-term and long-term securities. The rate on long-term securities should exceed the rate on short-term securities.

Some reasons for the rate differentials may be illustrated by comparing two investors with uncertain horizons, one holding bills and one holding ten-year maturity bonds. If it became desirable to convert these securities into cash, due either to price level changes, interest

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[108] _Ibid._, p. 165.

rate movements, or a need for cash, the billholder has advantages over the bondholder. Bills can be traded more quickly and with less risk of monetary loss because the short-term market is better organized than the long-term market. Also, if the market moves unfavorably or if cash is needed, a billholder has only three months to wait to realize his principal without going to the market, while a bondholder must wait ten years.[109] Basically, it seems that a bill has a greater degree of liquidity than a ten year bond. The concept of liquidity however, is significantly more complicated, and deserves additional attention.

In a recent article, J. R. Hicks[110] has examined the concept of liquidity in detail. Hicks minutely examines Keynes' definition of liquidity that:

> As a rule, advances to customers are more profitable than investments, and investments are more profitable than bills and call loans; but this order is not invariable. On the other hand, bills and call loans are more "liquid" than investments, *i.e.*, more certainly realisable at short notice without loss, and investments are more "liquid" than advances.[111]

Hicks, in examining this definition, provides some interesting tentative conclusions about the meaning of the term *liquidity*.

> An asset may be "realisable *at short notice* without loss" in the sense that the price at which it is realisable at short notice is much the same as that at which it is realisable at longer notice. Or, more accurately, the length of the notice that is given does not in itself have any important effect on the price at which the asset can be sold.

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[109] Joan Robinson, "The Rate of Interest," *Econometrica*, 49, No. 2 (April, 1951), pp. 92-111.

[110] J. R. Hicks, "Liquidity," *The Economic Journal*, LXXII, (December, 1962), No. 288, pp. 787-802.

[111] J. M. Keynes, *A Treatise on Money*, Vol. II (London: Macmillan and Co., Ltd., 1930), p. 67.

> The characteristic just described is an important characteristic which is related to liquidity, but it is not (I think) liquidity. Fortunately it has a name of its own. An asset which can be sold quickly just as well (apart from ups and downs of the market) as it can be sold after negotiation and perhaps advertising is a <u>marketable</u> asset. Evidently there are degrees of marketability.
>
> ...We seem therefore to be entitled to say (as a fair gloss on the Treatise definition) that liquidity is a characteristic which is <u>only</u> possessed by perfectly marketable assets; but that they do not possess that characteristic to the same extent.[112]

Marketability, then, is a necessary but not sufficient requisite for liquidity. The greater the degree of marketability, the greater should be the turnover rate per period, and also the lower should be the transaction cost (per dollar volume, or as a percentage of the bid price). Recently, H. Lawrence Miller, Jr., has argued that differences in transaction costs among securities may indicate degrees of difference in their liquidity.[113] An important aspect of Miller's argument is that transactions costs measure, among other things, the time and effort to actually effect the transaction--and that the time involved to bring buyer and seller together is important in the concept of liquidity.

Although time effecting the transaction, which may be measured in part by relative transaction costs, is a factor in the meaning of liquidity, it seems that liquidity implies something in addition. "Without loss" requires some <u>basis</u> for computation of gain or loss and each type of asset may have a different basis--as well as different bases for each holder. An obvious basis would be the acquisition price of the asset, but the

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[112] Hicks, <u>op</u>. <u>cit</u>., pp. 790-791.

[113] H. Lawrence Miller, Jr., "On 'Liquidity' and 'Transaction Costs'," <u>The Southern Economic Journal</u>, Vol. XXXII, No. 1, Part 1 (July, 1965), pp. 43-48. I am indebted to Professor James M. Murphy for helpful discussion regarding the liquidity concept.

generality of the term "liquidity" would be lost since the liquidity of any particular asset is dependent on various acquisition prices of the present holders. In this sense liquidity would have a very diverse meaning, dependent on the various acquisition prices and the movement of the rate since the time the "oldest" holder acquired the asset. A more meaningful concept of liquidity, and certainly one of greater generality, might be usefully oriented toward Tobin's differentiation of holders of short and long horizon. Various holding periods and the expected degree of rate fluctuation over relevant periods, with expectations based on past experience, provides a standard of "interest rate loss" to various assets.

Recently, Hicks and Luckett[114] among others, have attempted to define liquidity on the basis of relative dispersion, or expected dispersion (measured as the standard deviation), of rates of different assets over a particular holding period. Although Luckett is principally concerned with maturity measures of the Federal debt, his measure is relevant to this discussion:

> Substitutability for money is more likely related to their 'holding period yield'--the rate of interest plus or minus the capital gain or loss attendant upon holding a given security for a given length of time. Thus, the quarterly holding period yield, expressed as a percent per annum, of a particular security is -
>
> $$H = r + 400 \frac{(P_2 - P_1)}{P}$$
>
> where H is the holding period yield for three months r the (per annum) rate on the security, P_1 the buying price at the beginning of the quarter, and P_2 the selling price at the end of the quarter.

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[114] Hicks, op. cit. and Dudley G. Luckett, "On Maturity Measures of the Public Debt," The Quarterly Journal of Economics, Vol. LXXVII, No. 1, (February, 1964), pp. 148-157.

> It is true, of course, that the prices of long-term securities will typically move over a wider range than those of short-term and hence that variations in the holding period yields of long-term securities will be greater than those of short-term and hence that variations in the holding period yields of long-term securities will be greater than those of short-term securities...
>
> ...we may suppose that the marginal moneyness of the different maturities of debt takes on its value relative to variations in their respective holding period yields. We take as our measure of this variation the standard deviation of the holding period yields...[115]

Relative to the ten-year bond, the Treasury bill has greater marketability (a higher turnover rate and lower transaction costs) and has greater liquidity (lower standard deviation of holding period yields). "Liquidity" and "risk" are complicated and troublesome terms. Nevertheless, it would seem likely that the more nearly securities are alike in these characteristics, the more nearly they will come to yielding the same market rate of interest at any point in time. Generally, the market rate of interest on an eleven-week Treasury bill should not be very much different from the market rate on an eight-week Treasury bill. The more that securities are unlike in risk, maturity, marketability and liquidity, the greater the difference in yield movements over time. The more similar are the features that securities possess, the more substitutable they become in security-holders' portfolios, and the more dissimilar the features, the less they are substitutable.

Nevertheless, due to arbitrage, yields among different Federal securities will not diverge greatly for very long periods of time, and generally yields move in the same direction at approximately the same time. Indeed, this generalization was a basic assumption in the Federal Reserve

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[115] *Ibid*., pp. 154-155.

System's "bills-only" policy. Even more recently than "bills-only" it was pointed out that:

> Short- and long-term rates on U. S. Government securities have moved closely together over most of the period since 1950. Changes in credit conditions in one maturity sector of the Government securities market tend to be reflected more or less rapidly in other sectors. These changes also tend to be transmitted, though with varying force, to markets for private securities, affecting the availability of funds and the ease with which financing can be arranged as well as the interest cost.[116]

The _degree_ of the relationship among interest rates on various securities becomes important, and has relevance to whether microeconomic variables could be viewed as determining a particular rate, or whether it would be more appropriate to attempt to explain _the_ rate of interest using macroeconomic variables. If an extremely high degree of correlative relationship existed among rates, those variables which would explain the movements of any particular rate would do equally well in explaining any other rate.[117]

In order to examine the similarity of movement among rates, simple linear correlations were computed between the average monthly Treasury

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[116]Stephen H. Axilrod and Ralph A. Young, "Interest Rates and Monetary Policy," _Federal Reserve Bulletin_, 48 (September, 1962), No. 9, p. 1127. This article provides some very high quality description and analysis, and is relied on heavily in later Chapters of this study.

[117]For an effective theoretical and empirical attempt to explain an "average yield to maturity on Federal obligations" using primarily macroeconomic variables, see: Ralph Turvey, _Interest Rates and Asset Prices_ (London: George Allen and Unwin, 1960). The specific rate used as the dependent variable in his regression equations was made up of "...a weighted average of four interest rates on U. S. Government taxable securities which are published regularly in the _Federal Reserve Bulletin_: the rates on new issues of Treasury bills, 9-12 month issues, 3-5 year issues and long-term bonds. These were weighted 1, 2, 3 and 4 respectively in order to achieve a rough reflection of the average maturity structure of the debt held by the private sector..." pp. 70-71.

bill open-market rate and the rates of several other riskless securities.[118] The dissimilar characteristics between bills and these other marketable securities are either in liquidity, marketability, or both. Correlations were computed between the monthly average bill rate and: (a) the corresponding monthly Federal funds rate, (b) the monthly rate on 9-12 month United States securities, (c) the monthly rate on three to five-year United States Treasury notes and bonds, and (d) the monthly rate on Treasury bonds that are neither due nor callable for ten or more years.[119] The results of these simple correlations for the time period January, 1952 through December, 1964, are illustrated in Table 10.

It should be remembered that "expectations," referred to earlier as a reason for interest rate differentials, is not considered in these regressions. The simple correlation coefficients are smaller the longer the maturity. Viewing the correlation coefficients just off the diagonal indicates closer relationship between longer-term securities or between short-term securities than between a long-term and a short-term security. A general conclusion, again ignoring expectations, is that the longer the term to maturity of securities of equal price-level risk, and default risk

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[118] Joseph W. Conard, An Introduction to the Theory of Interest, (Berkeley: University of California Press, 1959). Conard makes use of scatter diagrams to show these relationships. An example using simple linear correlation of rates is: Arthur M. Okun, "Monetary Policy, Debt Management and Interest Rates: A Quantitative Appraisal," Stabilization Policies (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1963), pp. 331-380. Okun correlated quarterly rates on government securities, corporate bonds, and bank rates.

[119] A basic difference in these rates of bills are quoted on a discount basis (as is the Federal funds rate), while the rate on notes, bonds, and Certificates of Indebtedness are on a coupon basis.

TABLE 10.--Results of simple correlations between the Treasury bill rate (r_b), the rate on 9-12-month Treasury securities (r_{-1}), the rate on three-to-five-year Treasury securities (r_{3-5}), and the rate on Treasury bonds due in more than ten years (r_{10+}): monthly series; January, 1952 through December, 1964

Equations

$$r_b = .086 + .857\, r_{-1}$$

$$r_b = -\,.073 + .984\, r_{3-5}$$

$$r_b = -1.742 + 1.210\, r_{10+}$$

matrix of simple correlation coefficients

	r_b	r_{-1}	r_{3-5}	r_{10+}
r_b	1.000			
r_{-1}	.967	1.000		
r_{3-5}	.919	.970	1.000	
r_{10+}	.809	.860	.942	1.000

Source: The rate for long-term bonds was taken from the Annual Report of the Secretary of the Treasury on the State of the Finances for the Fiscal Year Ended June 30, 1964. The other rates were obtained from various monthly issues of the Federal Reserve Bulletin.

All rates are averages of daily closing figures. The bill rate used here is the same as that described in Chapter III. The 9-12-month rate is an average of Certificates of Indebtedness and selected note and bond issues. The three-to-five-year rate is an average of selected note and bond issues. The rate for the long-term bonds are based on maturities neither due nor callable for 15 years until March 31, 1952; on bonds neither due nor callable for 12 years through March 31, 1953, and from that time, bonds neither due nor callable for 10 years.

the less substitutability with Treasury bills. On the whole, however, the rates show high positive correlation.[120]

Another illustration of the general similarity of movement of these interest rates over time can be made by a comparison of the simple linear trend of the rates of Treasury securities over the period 1952-1964. The "a" values, "b" values, and the simple correlation coefficient "r" (for description of goodness of fit) are shown in Table 11.

TABLE 11.--Simple linear trend of Treasury bills, Treasury securities due within 9 to 12 months, Treasury securities due within three to five years, and Treasury securities due in more than 10 years: monthly series; January, 1952 through December, 1964[a]

Dependent variable		Constant		*b* value	r
r_b	=	1.4633	+	.0128 M	.67
r_{-1}	=	1.6368	+	.0144 M	.67
r_{3-5}	=	2.1494	+	.0139 M	.77
r_{10+}	=	2.5699	+	.0116 M	.91

[a]These rates are the same as those used in Table 10.

Source: See source of Table 10.

From Table 11, it can be seen that the average monthly increases over the period 1952-1964 are approximately the same for these four Treasury securities, about .012 to .014 per cent discount per month. Also, it

[120]According to traditional criteria the correlation coefficient (r) is appropriate for the relationships. However, it should be remembered that *r* always exceeds r^2 (the coefficient of determination). Since *r* is always greater than r^2, there is some danger that too much confidence will be attached to the larger measure. For a discussion of the technical aspects of this point, and for alternative measures, see Frederick A. Ekeblad, The Statistical Method in Business (New York: John Wiley and Sons, Inc., 1962), pp. 511-519.

is apparent (from the "a" values) that generally the longer the term to maturity, the higher the interest rate. In addition, the variability in the interest rates, as shown by the correlation coefficient which is intended simply as a measure of dispersion of the rates around the linear trend line, increases as the term to maturity increases. This indicates less volatile movements in long-term interest rates than in the shorter-term rates.

Also, it is evident that the similarity of the trend slopes is partially instrumental in accounting for relatively high correlation coefficients in Table 10. In order to obtain a better representation of the relationship between the bill rate and the other rates, avoiding the trend relationships, monthly changes in the rates were correlated.

These first differences in each series were correlated by simple linear regression. The results are shown in Table 12. The degree of relationship between monthly changes in the bill rate ($\dot{r}_b$) and the other individual rates ($\dot{r}$) was significantly less than were indicated in Table 10.

Viewing only the rates on the Federal obligations, $\dot{r}_{-1}$, $\dot{r}_{3-5}$, and $\dot{r}_{10+}$, the values for the simple correlation coefficients are respectively .74, .61 and .50. This would seem to indicate that the degree of the relationship between monthly changes in the bill rate and monthly changes in the other rates is closely associated with time to maturity. These results also cast some doubt on the assumption of the high degree of association of various interest rates.[121]

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[121] For a similar conclusion, see: Warren L. Smith, op. cit., p. 128. Smith correlated the weekly change in the long-term bond rate with weekly changes in the Treasury bill rate for the period January 4, 1958,

TABLE 12.--Results of simple correlation between monthly changes in the Treasury bill rate ($\dot{r}_b$), monthly changes in the rate on 9-12-month securities ($\dot{r}_{-1}$), monthly changes in the rate on three to five year securities ($\dot{r}_{3-5}$), and monthly changes in the rate on Treasury bonds due in more than ten years ($\dot{r}_{10+}$): January, 1952 through December, 1964

Equations					
$\dot{r}_b$	=	.0025	+	.845	$\dot{r}_{-1}$
$\dot{r}_b$	=	.0026	+	.940	$\dot{r}_{3-5}$
$\dot{r}_b$	=	.0005	+	1.564	$\dot{r}_{10+}$

Matrix of Simple Correlation Coefficients

	$\dot{r}_b$	$\dot{r}_{-1}$	$\dot{r}_{3-5}$	$\dot{r}_{10+}$
$\dot{r}_b$	1.000			
$\dot{r}_{-1}$	.743	1.000		
$\dot{r}_{3-5}$	.613	.819	1.000	
$\dot{r}_{10+}$	.501	.691	.862	1.000

Source: See sources of Table 10.

Yields on private securities could have been correlated with the bill rate, but it was felt that reference to Okun's results would provide sufficient empirical evidence of the degree of these relationships.[122]

to May 30, 1959. This resulted in a coefficient of determination of .1236, which is extremely near the value obtained above for the correlation of monthly changes.

An opposing conclusion was reached by Axilrod and Young, op. cit., p. 1127, after comparing the time series of "differences between observed interest rates and rates calculated from trend line, divided by standard deviation," for monthly levels of Treasury bills and twenty-year bonds for the period 1951-1962.

[122] Okun, op. cit. Okun's correlations are from quarterly series.

His results tend to indicate that the yields on private securities are not as highly related to the bill rate as the yields on other Federal obligations. Some examples of his results of the correlation between levels of the bill rate and levels of rates on selected securities (1949-I through 1959-III) show a coefficient of: .714 with corporate Aaa bonds, .556 with corporate Baa bonds, .852 with prime commercial paper, and .841 with high grade municipals.[123]

These results are not inconsistent with the above assumption that differences in rates on securities are related to different characteristics of securities. The differences between risk, maturity, and marketability are reflected in the values of the coefficients of correlation.

In all cases so far discussed, the relationships have been positive ones, indicating that, generally, the rates on these various securities move in the same direction.[124] Nevertheless, the degrees of the relationships differ widely. The relationship between monthly changes in the bill rate and monthly changes in the Federal funds rate was positive, but of a low degree. It has been pointed out in a recent study of the Federal funds market, that:

> Treasury bills are not really a good substitute for Federal funds because the latter are used primarily for one-day adjustments

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[123] Ibid., Table IV-6, p. 363. Okun's coefficient of correlation (.855) for the quarterly bill rate and the long-term bond rate is higher than the coefficient of correlation obtained in Table 10 (.809). The probable reason for this is that quarterly observations are used by Okun, while monthly observations were used above. In addition, Okun is using the average of weekly new bill issue rates for the last month of each quarter, and the time period is slightly different.

[124] Okun calculated negative coefficients between the bill rate and: (a) dividend yields on common stocks, -.501; and (b) earnings/price ratios of common stocks, -.463. Ibid.

> often involving quick turnarounds. Purchases of Federal funds and borrowing from a Reserve Bank are better substitutes--a primary reason for the closer relation between the discount rate and the Federal funds rate.[125]

Okun calculated the relationship between the bill rate and the discount rate of the Federal Reserve Bank of New York as having a coefficient of correlation of .955.[126] The correlation of the bill rate with the discount rate for monthly series is the same as correlating the bill rate with itself. This is especially apparent if monthly changes in the bill rate are compared with the difference between the bill rate and the discount rate. The movements of the two resulting series will be identical, differing only by a constant, unless the discount rate changes. In the period of 1952-1964, (156 monthly periods), the discount rate of the Federal Reserve Bank of New York was changed 22 times, or an average of approximately twice each year.

Although rates on various securities move generally in the same direction, the empirical relationships that have been observed indicate that the degree of association between the bill rate and other rates is not so high as to rule out a microeconomic, partial-equilibrium investigation. If a security such as a Treasury bill has particular qualities which differentiate it from other assets, it seems legitimate to analyze the market for this security and attempt to measure the causal factors determining this rate (price). In a famous essay, Joan Robinson has noted:

> Keynes' theory treated the rate of interest as determined by the demand and supply of money. This was a useful simplification in

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[125] The Federal Funds Market (Board of Governors of the Federal Reserve System, Washington, D. C., 1959), p. 102.

[126] Okun, *op. cit.*, p. 363.

> the pioneering days of the theory, but it was always obvious that there is no such thing as the rate of interest and that the demand and supply of every type of asset has just as much right to be considered as the demand and supply of money.[127]

Nearly the same conclusion has been stated by Gaines in his analysis of the management of the Federal debt.

> ...the rate of interest on United States Government securities, as for any market price, is a function of supply and demand, the latter encompassing the prices of acceptable substitutes relative to their degree of substitutability, the structure of tastes, and the state of expectations.[128]

It has also been shown through the empirical relationships that there are securities which are very good substitutes for Treasury bills, particularly other Federal obligations.[129]

The Term Structure of Rates

The relationships among rates on securities which differ only in the length of their maturities, is interesting and important. Recently, much theoretical and empirical effort has been devoted to attempting to explain the term structure of interest rates--the pattern of the rates displayed graphically by measuring the market rates on the vertical axis and time to maturity on the horizontal axis. Various hypotheses to explain rate differentials have been formulated and supported with statistical evidence. Generally, the hypotheses regarding the pattern of the term structure of rates have been classified as: expectational, institutional and eclectic.

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[127] Robinson, *op. cit.*, p. 5.

[128] Gaines, *op. cit.*, p. 257.

[129] This fact emphasizes the need for working from a clear conceptual basis in attempting to assign causes to bill rate movements. Basically, a consistent theoretical framework is necessary, and will be developed in Chapter V.

The expectational theory states that the long-term rate is an average of the expected short-term rates over the life of the long-term debt. David Meiselman, in explaining the expectation hypothesis (associated with the work of Frederick A. Lutz, among others) has provided a summary of some of the principal tenants.

> The expectations hypothesis follows from the assumption that short- and long-term securities can be treated as if they were perfect substitutes and that transactors, indifferent to uncertainty and having similar expectations, equate the forward rates in the market to the expected rates. As a matter of descriptive reality, individual transactors may still speculate or hedge on the basis of risk aversion, but the speculators who are indifferent to uncertainty will bulk sufficiently large to determine market rates on the basis of their mathematical expectations alone.[130]

Although Lutz is credited with presenting one of the most logical statements of the expectational hypothesis, he also provided some qualification of the "pure" expectational view by stating that:

> ..., in addition to costs and uncertainty, certain institutional factors also influence the structure of interest rates....English banks aim at keeping a certain relatively fixed percentage of their assets in the form of cash and short material....This makes it possible for the Treasury to cause the short rate to fall below the long rate simply by curtailing the issue of treasury bills. The discrepancy will last as long as the shortage of treasury bills continues, and is one which cannot be explained in terms of expectations.[131]

Curiously, this statement by Lutz is essentially the position taken by the institutional view of the determination of the term structure of rates. The institutional theory asserts that substitutability between short-term securities and long-term securities is limited by preferences

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[130]David Meiselman, The Term Structure of Interest Rates (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1962), p. 10.

[131]Frederick A. Lutz, "The Structure of Interest Rates," Reprinted in the American Economic Association, Readings in the Theory of Income Distribution, Edited by William Fellner and Bernard F. Haley (Philadelphia: The Blakiston Company, 1951), pp. 519-520, fn. 19.

of borrowers and lenders, and consequently the relative quantities of various maturities are important in determining rate differentials. J. M. Culbertson has offered an hypothesis, critical of the purely expectational view, that characterizes the institutional explanation. In summarizing his theory, he has stated:

> Rates on short-term and long-term U. S. government securities, which are tied to rates on related private debt, characteristically move simultaneously in the same direction in the short run (over periods of weeks and months), with short-term rates changing over the wider range. The general coincidence of movement in rates reflects basically the simultaneous impact in various credit markets of changes in general credit conditions resulting from changes in business conditions and monetary policy, and substitutability between short-term and long-term debt on the part of both borrowers and lenders. However, this substitutability is limited in extent, and when the maturity structure of debt supplied to the economy undergoes a substantial short-run change, either because of Treasury debt management operations or actions of private borrowers, this is reflected in the rate structure. Yields on short-term debt average lower than those on long-term debt because of the advantage of the superior liquidity of such debt to the holder and the liquidity disadvantage of issuing such debt to private borrowers.[132]

Clearly, there are a great number of possibilities for combining elements of the purely expectational and purely institutional hypotheses. Many different versions of the explanation of the term structure have been provided, differing primarily in the relative weights applied to the alternative hypotheses. The quotations above are included to provide some representative views of the alternative explanations.

An example of the eclectic approach is provided by Burton G. Malkiel, who has collected evidence which leads him to conclude:

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[132] J. M. Culbertson, "The Term Structure of Interest Rates," The Quarterly Journal of Economics, LXXI, No. 4 (November, 1957), pp. 488-489.

> ...my study reaffirms the importance of expectations in the determination of the term structure,....Moreover, I disagree with both extreme views on the matter--the one which assigns to expectations the unique and complete role in determining the rate structure and the other, which offers them no role at all....I believe that emendations must be made to the expectations analysis to account for transactions costs, diversity of expectations, and institutional maturity preferences on both sides of the market. These suggest that supply levels do affect the term structure.[133]

A very simple framework for explaining movements of the bill rate in terms of demand for and supply of bills is developed later in this study. This approach implies that changes in the supply of bills are relevant to the determination of the bill rate. Also, changes in the demand for bills are assumed to be relevant, although measurement becomes much more difficult. A change in expectations of bill market participants certainly would be assumed to cause demand shifts, but the principal problem lies in the measurement of expectations. Meiselman, utilizing an error learning model, has avoided any requirement for an independent measure of expectations by calculating an expected rate from *ex post* rates. With relatively simple tools, Meiselman has provided some strong support for the expectational hypothesis.

It will be apparent in the following chapters that, although no attempt is made to explain the term structure of rates, this study of the determinants of the bill rate is much more closely allied to the institutional than the expectational theory. Attempts are made in the later

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[133] Burton G. Malkiel, "The Term Structure of Interest Rates," *American Economic Review Papers and Proceedings*, Vol. LIV, No. 3 (May 1964), pp. 542-543. See also Jacob B. Michaelson, "The Term Structure of Interest Rates and Holding-Period Yields on Government Securities," *The Journal of Finance*, Vol. XX, No. 3 (September, 1965), pp. 444-463.

portion of the study to measure the effects on the bill rate of changing supply and demand factors. In a discussion of Malkiel's paper quoted above, Okun commented that:

> A modified expectationist should believe that relative supplies make a difference, as Malkiel demonstrates. Longs and shorts are not perfect substitutes, even though the world is not segmented. A priori arguments cannot determine the importance of relative supplies: It is a matter of degree which requires statistical analysis....I consider the issue very much open and sorely in need of more econometric work, especially work pursuing a less aggregative approach.[134]

In a sense, the present study is on a lower level of aggregation than most of the studies surveyed in this section. Meiselman, for instance, utilizes yearly observations in the empirical support of his hypothesis. Although the term structure of rates is important to this study, an extensive analysis and test of hypotheses regarding rate differentials is considered outside the scope of the study.

The Relationships among Bills of Different Maturities

Up to this point, Treasury bills of different length time-to-maturities have been assumed to be perfectly substitutable. Actually, substitution is not perfect although the degree of substitutability among different maturities is apparently high. Perfect substitutability would imply identical yields if expectations were ignored, and this is not the

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[134] Arthur Okun, "Comment on Malkiel's 'The Term Structure of Interest Rates'," American Economic Review Papers and Proceedings, Vol. LIV, No. 3 (May, 1964), pp. 556-557. For some surveys of studies of the term structure of rates, see: Joseph Aschheim, Techniques of Monetary Control (Baltimore: The Johns Hopkins Press, 1961), pp. 55-60; Conard, op. cit.; Axilrod and Young, op. cit.; Turvey, op. cit., pp. 91-99; and John H. Wood, "Expectations, Errors, and the Term Structure of Interest Rates," The Journal of Political Economy, Vol. LXXI, No. 2, (April, 1963), pp. 160-171.

case. Therefore, it is necessary to examine the relationships among the various classifications of Treasury bills.

There are, at any point in time, 13 different issues of original 91-day Treasury bills outstanding, plus 13 issues of original 182-day bills having more than 91 days to maturity,[135] as well as various issues of nine-month bills, one-year bills, and tax-anticipation securities. For the regular issues of 182-day bills, nine-month bills, and one year bills, those having less than 91 days to maturity are perfectly substitutable with those original 91-day bills having the same maturity.

Nevertheless, those issues of bills outstanding with less than 91 days to maturity do not yield identical rates. Indeed, a pattern of rates exist at any time, the most common pattern being one in which the greater the weeks to maturity, the higher the yield.[136] The asked yields usually exhibit a slightly higher average difference than the bid yields because the dealer's spread is a relatively constant amount. When the amount is converted to "yield to maturity," the nearer the bill to maturity, the smaller is the yield which is derived from the amount.

Closing bid yields for outstanding issues of 91-day bills for the last trading day of the month are shown in Chart 5, for the seven months beginning November, 1955, through May, 1956. The vertical axis has been broken in order to make the differences more perceptible, and the maturity dates are measured on the horizontal axis. The patterns are plotted as of the end of the month, each pattern therefore moving four or five grids to

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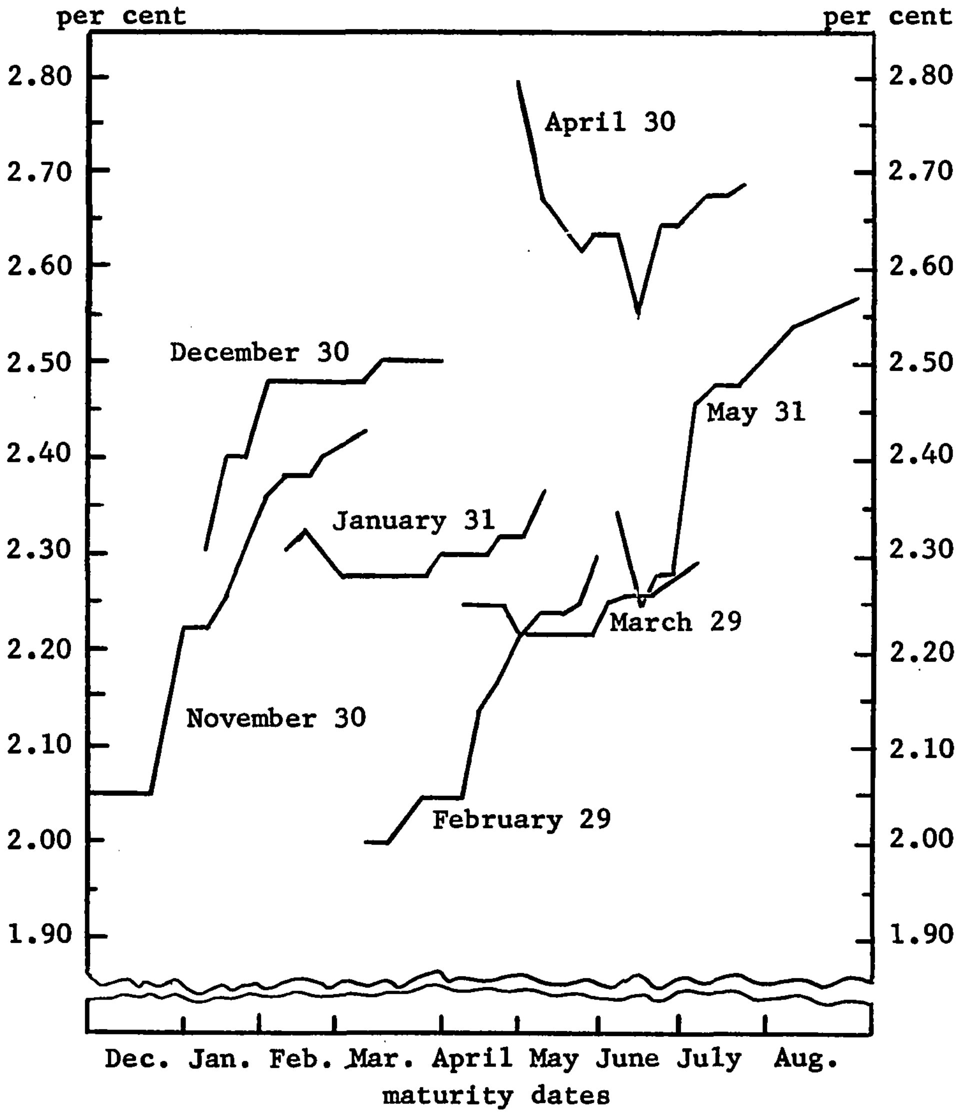
[135] Prior to December 11, 1959, only the 91-day bills were in existence. The description of the newer issues is provided in Chapter II.

[136] Conard, op. cit., pp. 323-324.



Source: Treasury Bulletin, various issues.

Chart 5.--Yield to maturity patterns for 91-day bills outstanding at end of indicated month, for November, 1955, through May, 1956.

the right due to the passage of time between the end-of-month dates. It is evident from the Chart that not only does the general level of rates change over time, the pattern of the rates changes as well.

Chart 6 shows the relationship between bid and asked yields for bills having 26-and-fewer weeks to maturity. Again the vertical scale is broken, rates measured on the vertical axis, and maturity dates measured on the horizontal axis. This particular pattern of rates is for April 23, 1962.[137] The spread between bid and asked yields becomes very wide near maturity as the absolute spread is discounted over only a few days. It is interesting that the spread widens sharply between 13-week and 14-week bills. In this case there is a difference of three basis points in the dealer's spread between these two maturities, although the bid rates for the two maturities are identical.

The pattern of the bid rates shows a slight dip after 13-weeks to maturity, then increases rather sharply. The pattern of the asked rates increases relatively steeply and smoothly up to 13-weeks to maturity, dips sharply, then moves rather steadily upward.

In order to examine the degree of relationship among various types of Treasury bills, the following average monthly rates have been correlated:[138]

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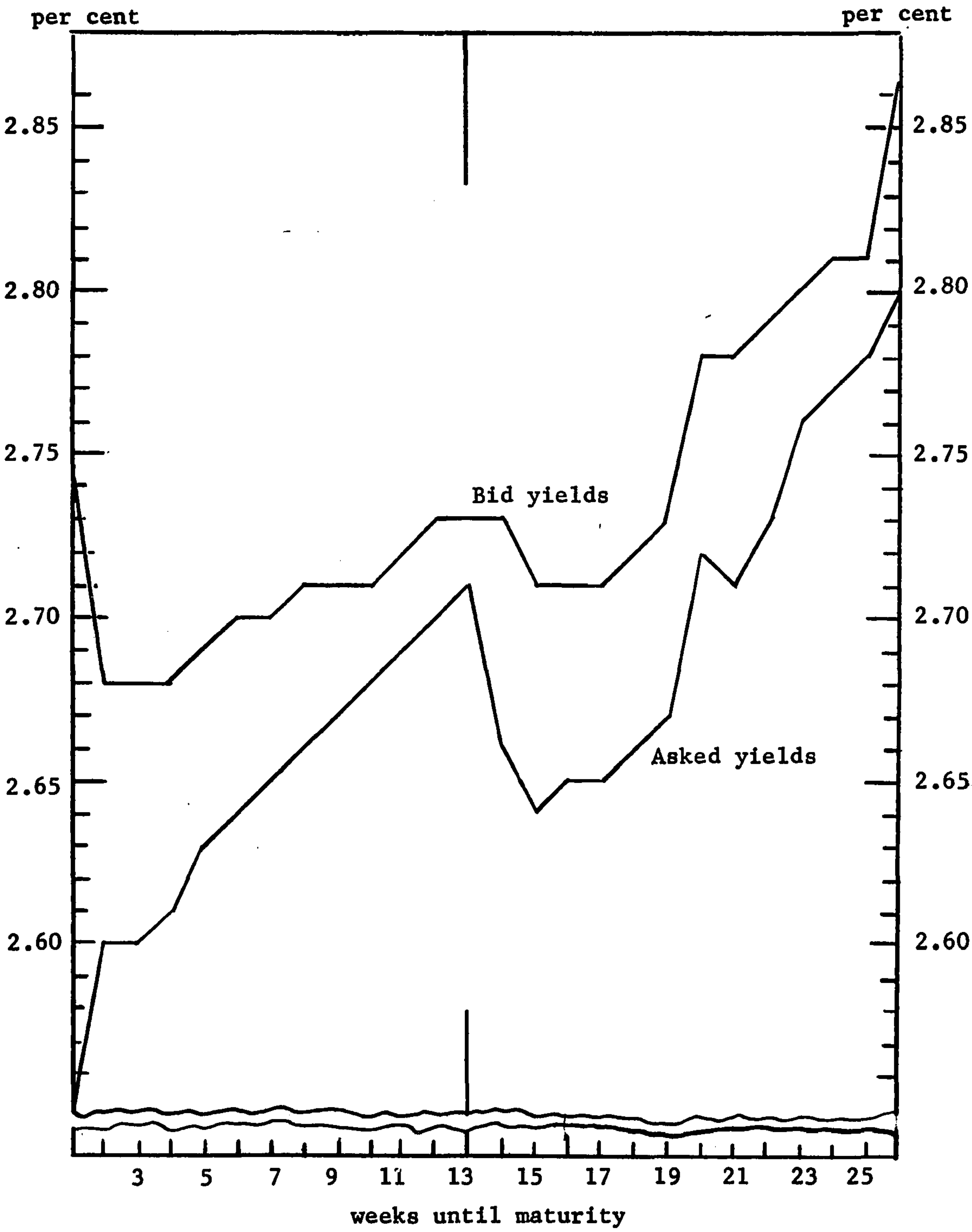
[137]These are quoted rates, and not necessarily the rates or spreads which will be realized. Also, these rates are quoted accurately to two decimal places, which clearly indicates rounding problems for a fixed dealer charge for large transactions. The rates are from The Wall Street Journal, April 24, 1962.

[138]These rates are from the Federal Reserve Bulletin. The description of the averages is included in Table 13. It would have been interesting to view the weekly relationships, but this was not done. Anyone contemplating weekly correlations should be cautioned that a data problem



Source: The Wall Street Journal, April 24, 1962.

Chart 6.--Pattern of bid and asked yields, showing quoted spread, for bills maturing in one-to-26 weeks, on April 24, 1962.

(a) r_1, the new-issue 91-day-auction rate,

(b) r_2, the market rate on 91-day bills outstanding,

(c) r_3, the new-issue 182-day-auction rate,

(d) r_4, the market rate on 182-day bills outstanding, and

(e) r_5, the market rate on 9-12-month bills outstanding.

Since there were no bills other than 91-day bills prior to December, 1959, these relationships are calculated for the period January, 1960, through December, 1964. These simple linear regressions are done on a monthly basis, with r_1 serving as the variable on the ordinate in all cases. The results are shown in Table 13.

The closeness of the relationship between the average new-issue 91-day Treasury bill rates and the rates on other bill maturities is evident in Table 13. The _a_ and _b_ values indicate that there was nearly a one-to-one relationship between the correlated rates, with the constant and the regression coefficient both decreasing slightly with the longer maturities. The correlation coefficients also decrease as the average monthly new-issue 91-day bill rate is correlated with bills on longer maturities. The value of the correlation coefficient shown in Table 10 for the average monthly open-market rate of securities (not including bills) maturing within one year was .967; which compares with the correlation coefficient of .982 between the 91-day new-issue bill rate and the 182-day new-issue bill rate. These coefficients are slightly higher than the coefficient of .951 obtained between the 91-day new-issue bill rate and the

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exists in the published weekly series. The new issue rates are for the Monday auction, while the market rates are averages of daily rates for the week ending the following Saturday. Less lag would be present if the Monday auction rates were paired with the market rate of the preceding Saturday.

TABLE 13.--Simple linear relationships between the average monthly levels of new 91-day bill rates (r_1), and: the average monthly open-market 91-day bill rates (r_2), the new-issue 182-day monthly average rates (r_3), the monthly average open-market 182-day rates (r_4), and the monthly average 9-12-month open-market bill rates (r_5); January, 1960 through December, 1964[a]

Equations

$$r_1 = .028 + .997\ r_2$$

$$r_1 = .126 + .982\ r_3$$

$$r_1 = .125 + .987\ r_4$$

$$r_1 = .138 + .951\ r_5$$

matrix of simple correlation coefficients

	r_1	r_2	r_3	r_4	r_5
r_1	1.000				
r_2	.997	1.000			
r_3	.982	.972	1.000		
r_4	.987	.981	.997	1.000	
r_5	.951	.938	.986	.980	1.000

[a]All rates are monthly averages. The new-issue rates, r_1 and r_3, are averages for the Treasury bill auctions held during the month. The open-market rates are monthly averages of daily closing rates. The rates included in these averages are: for r_2, all bills having less than 91-days to maturity-regardless of their maturity at issue; all bills having between 91 and 182 days to maturity (r_4); all bills having between 182 and 360 days to maturity (r_5).

Source: Monthly issues of the Federal Reserve Bulletin, February, 1960-February, 1965.

9-12-month open-market bill rate. Although the difference in time periods (1952-1964 as opposed to 1960-1964) do not allow direct comparability between these results, the coefficients of determination in Table 13 are generally higher than the coefficients in Table 10.

In order to lessen the effect of the trend relation in these rates, the same correlations were calculated, for the same time periods, using first differences ($\dot{r}$), and the results are presented in Table 14.

TABLE 14.--Simple linear relationships between first differences of monthly new-issue 91-day bill rates ($\dot{r}_1$), and: the first differences of the open-market 91-day bill rates ($\dot{r}_2$), the first differences of the new-issue 182-day bill rates ($\dot{r}_3$), the first differences of the monthly 182-day open-market bill rates ($\dot{r}_4$), and the first differences of the 9-12-month open-market bill rates ($\dot{r}_5$): monthly; January, 1960 through December, 1964

Equations

$$\dot{r}_1 = -.002 + .922\, \dot{r}_2$$
$$\dot{r}_1 = .003 + .879\, \dot{r}_3$$
$$\dot{r}_1 = .002 + .867\, \dot{r}_4$$
$$\dot{r}_1 = .003 + .748\, \dot{r}_5$$

matrix of simple correlation coefficients

	$\dot{r}_1$	$\dot{r}_2$	$\dot{r}_3$	$\dot{r}_4$	$\dot{r}_5$
$\dot{r}_1$	1.000				
$\dot{r}_2$	.962	1.000			
$\dot{r}_3$	.953	.906	1.000		
$\dot{r}_4$	.942	.955	.970	1.000	
$\dot{r}_5$	.887	.894	.925	.934	1.000

Sources and notes: See Table 13.

The conclusions from Table 14 are generally the same as those above from Table 13. All the correlation coefficients for these first difference correlations are quite high compared with those obtained in Table 12, indicating a close relationship among the movements of these monthly average bill rates. The slopes of these regressions indicate a near one-to-one relationship between changes in the 91-day new-issue bill rate and changes in the 91-day open-market bill rate, with the ratio decreasing gradually as the time-to-maturity classification of the bill increase.

Additional information relative to the level of variation of these average monthly rates over this four year period is obtained from Table 15. Presented in this table are the arithmetic means, standard deviations, and coefficients of variation in percentage form, $100 \cdot (s_x/\bar{X})$, of the level of rates; plus the arithmetic means and standard deviations of the first differences in the rates. A very close relationship exists among the average level of the rates, the average changes of the rates, and the variation of the rates over this period.[139]

The high values of the correlation coefficients between both the levels and the first differences of these relationships indicate that the degree of substitutability between bills of different maturities seems to be higher than substitutability between either the average monthly bill rate and longer-term rates on Treasury notes and bonds, or rates on private securities. The relationship between the 91-day open-market bill rate and the 9-12-month open-market Certificate and note rate is quite similar

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[139] Monthly changes for these five rates were not always in the same direction, although this was usually the case. A sign test for randomness of the direction of change indicated that there were too few runs of signs to conclude that these changes were random.

TABLE 15.--Arithmetic means, standard deviations, and coefficients of variation for monthly levels of bill rates; and means and standard deviations for changes in bill rates of different maturities: for the period January, 1960 through December, 1964

Variables	Levels			First differences	
	$\overline{X}$	s_x	c.v.	$\overline{X}$	s_x
r_1	2.962	.517	17.5	-.010	.164
r_2	2.943	.522	17.7	-.009	.171
r_3	3.145	.509	16.2	-.015	.178
r_4	3.128	.506	16.2	-.014	.176
r_5	3.260	.479	14.7	-.168	.194

Source: Calculated from rates described in Tables 13 and 14.

to the empirical relationship calculated between the 91-day new-issue rate and the 9-12-month open-market bill rate, even though the time periods were different, 1952-1964 and 1960-1964 respectively.

According to the values of the correlation coefficients, those securities issued by the Federal government having less than one-year to maturity are highly substitutable for Treasury bills, and Treasury securities having maturities exceeding one-year, plus those securities issued privately (regardless of maturity) are not as highly substitutable for bills.

It seems legitimate, therefore, to analyze the determinants of the rate on short-term Federal debt instruments independently, assuming the market forces in the short-term market are different from the forces in the longer-term market. The division at the one-year maturity classification is rather arbitrary, but according to the values of the correlation coefficients, it seems that the degree of association between the bill rate and variables of greater than one-year to maturity is not so significant. The high degree of substitutability between 91-day bills and bills of other maturities seems to justify speaking of a market for Treasury bills, treating the different bill maturities as highly substitutable.

Nevertheless, the high degree of association between the bill rates and the 9-12-month Certificate and note rates raises some doubts as to whether the market is for bills or for securities of equivalent risk having less than one-year to maturity. If the market for bills is to be studied, some account must be taken of those securities having less than one-year to maturity because of the apparent high degree of substitutability with bills.

Summary

The degrees of association between bills and longer-term maturities and private securities seems low enough to justify a microeconomic, partial-equilibrium theoretical framework for the analysis of the bill market. Given the degree of association among levels of all interest yields, the theoretical framework becomes important. In the empirical portion of this study, independent variables must be chosen on the basis of relevance to the Treasury bill market, not simply on the basis of relevance to the general level of all rates. The selection of variables to explain the bill rates must be consistent with predetermined theoretical hypotheses, rather than selecting those variables which prove reduction of unexplained variances and provide high coefficients of multiple determination. Given the great amount of monetary, debt, and security market data, a high coefficient of multiple determination is not very difficult to obtain;

especially if problems such as multicollinearity, autocorrelation, or other statistical biases are ignored. Care must be taken to include only those variables which are theoretically relevant and plausible.

Therefore, in the following Chapter, the basic theoretical framework for explaining the movements of the Treasury bill rate will be developed.

CHAPTER V

SOME THEORETICAL AND METHODOLOGICAL ASPECTS OF THE ANALYSIS

Introduction

The usual approach in a general-equilibrium model of interest rate determination is to view money as the asset demanded and debt instruments as the asset supplied. The demand schedules relate to cash or funds demanded at various interest rates (prices), and the supply schedules relate to quantities of bonds that are supplied at various interest rates (prices).

This concept of supply and demand, however, is too general for the partial-equilibrium analysis used in this study, if for no other reason than that only a single debt instrument, United States Treasury bills is examined. Although it is true that a holder of bills has made a choice between holding bills instead of cash, it also is true that he has chosen among all other interest-bearing assets. In order to isolate Treasury bills as a commodity, bills are viewed as being supplied and demanded. The supply schedules refer to the quantities of bills that would be supplied to the market at various interest rates (prices), and the demand schedules refer to the quantities of bills that purchasers desire to buy at various interest rates (prices).

The United States Treasury is the sole supplier of bills in the primary market, and only the Treasury can increase or decrease the total quantity, or stock, of bills. However, due to the marketability of the Treasury bill, all present holders of bills are potential suppliers in the secondary market. At any time bill-holders, such as commercial banks or non-financial corporations, may wish to sell a part or all of their bill holdings for any of a multitude of reasons. At the same time, there are bill-holders who are ready to increase their holdings and there are non-holders who desire to buy bills. These secondary market transactions are conducted through Government securities dealers, who also are increasing or decreasing their portfolios of various bill maturities. The great volume of trading of bills is evidence that at all times decisions to buy and sell are being made and executed.

Viewed in this manner, it is evident that each participant in the bill market is continually making decisions as to the quantities of bills he wishes to hold in response to his financial situation and the conditions of the securities markets. Holding financial situations, conditions of the securities markets, expectations, and all other relevant variables constant, some type of supply and demand schedules can be drawn to explain the actions of the individual market participants. These individual schedules may then be aggregated into market demand and supply schedules. This approach thus allows a partial-equilibrium analysis of the movements of the bill rate, in which the Treasury bill is considered as a commodity and the rate of interest as its price.[140]

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[140]This treatment of the interest rate in securities markets is provided in several intermediate theory textbook treatments. Some examples are: Kenneth E. Boulding, Economic Analysis (London: Hamish Hamilton, 1955), Third Edition, pp. 93-98; James M. Henderson and Richard E. Quandt, Microeconomic Theory: A Mathematical Approach (New York: McGraw-Hill Book Co., Inc., 1958), pp. 250-251; W. J. L. Ryan, Price Theory

Before attempting to illustrate various types of bill market behavior in this framework, some mechanical technicalities must be examined.

Problems of Measurement

When graphically illustrating demand and supply schedules, it is customary to indicate the price of the commodity on the vertical axis and the quantity of the commodity demanded or supplied on the horizontal axis. The price of a Treasury bill has traditionally been in terms of the price per $100 maturity value, discounting the interest for the time to maturity. If this price is measured on the vertical axis for demand and supply schedules, the quantity axis therefore, will measure the number of $100 worth of bills at their maturity--which is certainly not a very convenient measure. Bills are issued in various denominations, the smallest being $1,000, and consequently it is not feasible to speak of the number of bills outstanding. Since the price is tied to the quantity through a scale factor ($99.00 for $100.00 maturity value meaning the same as $990.00 for $1,000.00 maturity value), a convenient way to measure the price and quantity of bills is the price per one dollar maturity value, while allowing the quantity axis to measure the quantity of bills in dollar value at maturity. This approach is illustrated in Chart 7.

Nevertheless, using the price of bills on the vertical axis has several disadvantages that restrict the interpretation of graphical illustrations of demand and supply schedules, especially if it is desired to

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(London: Macmillan and Co., Ltd., 1960), pp. 209-240; and Erich Schneider, Pricing and Equilibrium: An Introduction to Static and Dynamic Analysis (New York: The Macmillan Company, 1962), Sixth German Edition translated by Esra Bennathan, pp. 271-280.

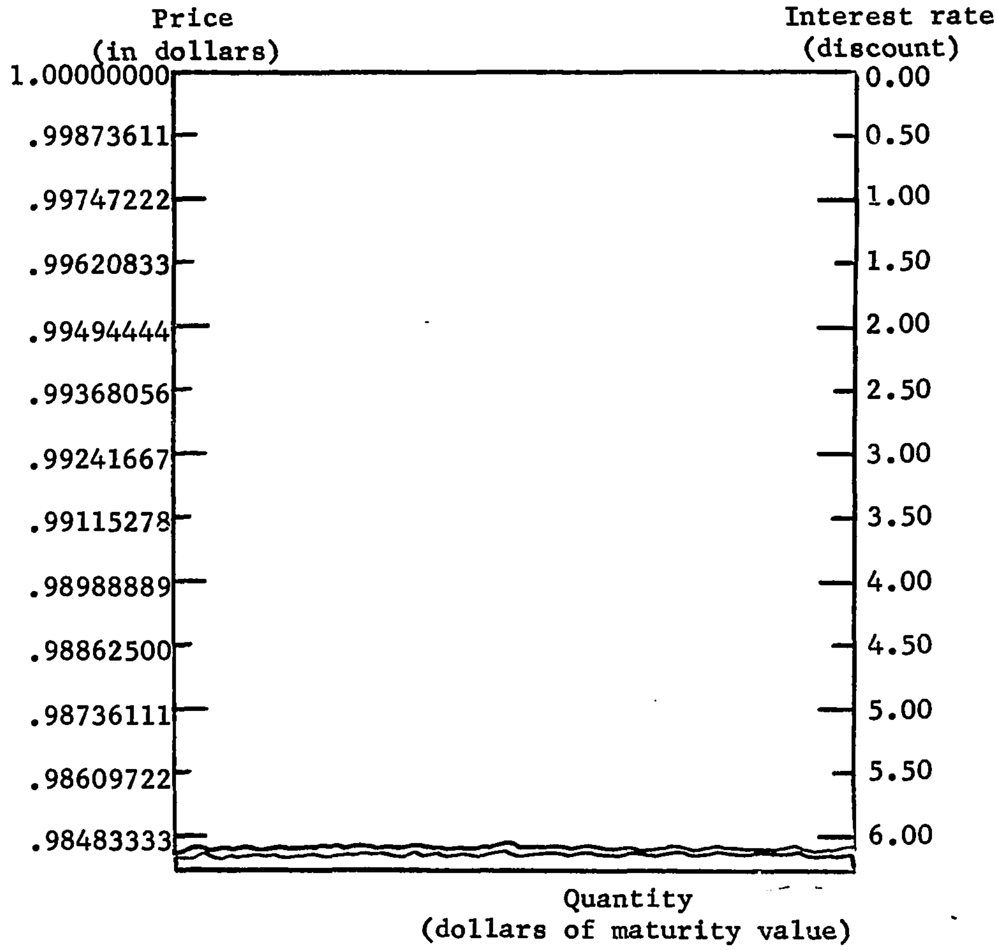

Chart 7.--The relationship between the price and the discount rate of Treasury bills with 91-day maturities.

present anything resembling a realistic situation. First, the extremely short maturity of the Treasury bill necessitates the bunching of the relevant prices at the extreme upper end of the vertical axis near the price of par, yielding a demand schedule with almost imperceptible slope.[141] Unless the vertical axis is broken, excluding the irrelevant prices, it would be difficult to distinguish between the demand schedule and the supply schedule.

A more important objection to using price on the vertical axis, even if the scale is broken, is that the demand and supply schedules will shift as the time to maturity changes. Consider, for example, the case when the bill rate remains constant and the demand and supply preferences are unchanged. Then, if the daily average of closing bid prices of all 13 issues of original 91-day bills is the specific price used, the schedules would move daily for a week as the average maturity became shorter, then jump back to the original position when the shortest bill matured and was replaced by a new issue with exactly 91-days until maturity. In addition, it seems that the rate of interest is a more relevant measure for the vertical axis since it has greater generality, and is more directly comparable with longer-term security prices.[142]

In the presentation of the demand and supply schedules for bills, the bill rate is measured from zero at the point of origin, increasing up

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[141] In the case of prices measured per one dollar maturity value, the price would be near one dollar. Prices below \$.985 for a bill having less than a 91-day maturity correspond to bill rates of six per cent or greater.

[142] Direct comparability can be obtained only if the bank discount rate is converted to the corresponding coupon rate.

the vertical scale, and the quantity of bills is measured on the horizontal axis in dollars of maturity value. Now, however, the demand schedule is upward sloping and the supply schedule downward sloping. This is illustrated in Chart 8.

This approach brings about no particular difficulties, except that, normally, demand curves are pictured as downward sloping, supply curves are pictured as upward sloping, and some reorientation is required when this normal situation is reversed. There is no difference as far as the meaning of the schedules as a representation of market behavior. Neither is there any difference in the meaning or the measure of elasticity in the technical sense, except that the usually ignored algebraic sign of the value of the elasticity is reversed.

The simple framework of Chart 8 illustrates the quantities of bills that will be demanded at various interest rates, the quantities to be supplied at various rates, and the equilibrium rate set at the intersection of the demand and supply schedules. The quantity indicated at the intersection of the schedules is the quantity of bills, measured in terms of their maturity value, which will be traded per unit of time. *Ceteris paribus*, an increase in demand (a shift in the demand schedule to the right), or a decrease in supply (a shift in the supply schedule to the left) will cause the equilibrium rate to decrease. *Ceteris paribus*, increases in the rate will be brought about by a decrease in demand or by an increase in supply.

Nevertheless, when these schedules are viewed in the behavioral sense, they become clumsy. It is difficult to divide the market participants into demanders and suppliers. Any individual participant in the

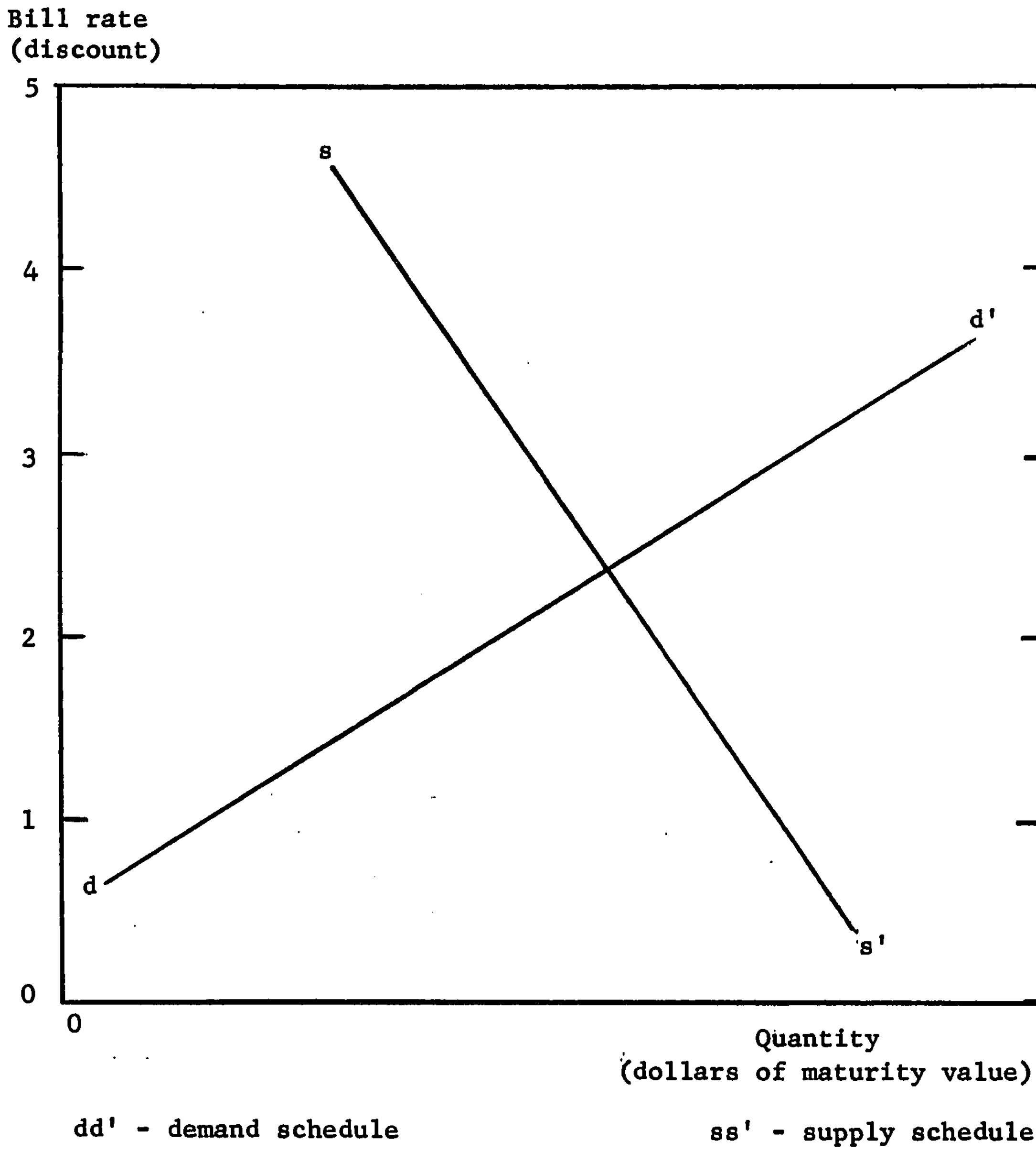

Chart 8.--Demand and supply schedules for Treasury bills measuring the discount rate on the vertical axis, with the rate increasing up the scale from the origin.

market may be willing to buy at some rates, but willing to sell at other rates, causing a single economic unit to be counted in both the demand and supply schedules.

Reserve Demand

It is more relevant to view the quantity of bills that individual participants desire to hold at various interest rates. Viewed in this manner, there is no need to dichotomize the market into demanders and suppliers. There are several other advantages in using this approach: (a) it is possible to separate the effects of the primary market from those of the secondary market, (b) there is no need in the empirical formulations to have data on the quantity of bills traded per unit of time, and (c) the explanations of movements to and from equilibrium rates are simplified.

If the total supply of Treasury bills available in the market can be viewed as a stock,[143] the concept of "reservation" price as developed by Wicksteed is useable.[144] Wicksteed argued that present holders of a

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[143] The stock concept will be discussed in greater detail in Chapter VI.

[144] Philip H. Wicksteed, The Common Sense of Political Economy, Vol. II, Revised Edition (London: George Routledge and Sons, Ltd., 1933), Chapter IV, and p. 785. An explanation of Wicksteed's concept with a discussion of excess demand and supply functions is given in: M. Blaug, Economic Theory in Retrospect (Homewood, Ill.: Richard D. Irwin, Inc., 1962), pp. 439-440. Wicksteed's demand schedule is utilized in regard to securities markets in Schneider, op. cit., pp. 271-280, and Erich Schneider, Money, Income and Employment, Translated from the fifth German edition by Kurt Klappholz (New York: The Macmillan Company, 1962), pp. 69-76. For further discussion, including a criticism of Wicksteed for neglecting the wealth-effect, see: Samuel B. Chase, Jr., Asset Prices in Economic Analysis (Berkley: University of California Press, 1963), p. 39, and pp. 94-95.

commodity have reservation prices, prices below which they will demand to retain the commodity rather than sell it in the market. Applying this concept to the Treasury bill market, present bill-holders have reservation rates above which they demand to hold the quantity of bills in their possession. The reserve demand schedule (total demand schedule) is the sum, at each rate, of the quantities that present holders wish to retain, and the quantities that holders and non-holders wish to buy (new demand).

This concept is illustrated in Table 16 and Chart 9. Given the stock of bills available to the market, 25 units in this case, at a rate of 3.5 per cent suppliers will desire to hold 15.0 units (25.0 units minus 10.0 units), while new demand exists for 12.5 units. At a rate of 3.5 per cent, 27.5 units of bills are desired while the stock totals only 25 units. Therefore, excess demand exists and equilibrium cannot be established at this rate. At a rate of 2.5 per cent, new demand plus reserve demand (6.25 units plus 11.0 units respectively) totals 17.25 units, illustrating an excess supply (or negative excess demand) of bills at this rate. In this example, the equilibrium rate stands at 3.256 per cent. At this level new demand plus reserve demand is equal to the stock, or the excess demand and the excess supply equal zero.[145]

If the reserve demand schedule is used, there is no need to be concerned about the quantity of bills that change hands during each time period. The relevant schedule is the quantity of bills that the economy desires to hold at various interest rates.

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[145] "Wicksteed's total demand curve is also the excess demand curve with the axis transposed." Blaug, op. cit., p. 440.

TABLE 16.--Hypothetical demand and supply schedules for Treasury bills and the derivation of the total demand schedule[a]

r	Q_d	Q_s	$V - Q_s$	D
0.0	--	25.000	0.000	0.000
0.5	--	22.000	3.000	3.000
1.0	--	20.000	5.000	5.000
1.5	0.000	18.000	7.000	7.000
2.0	3.125	16.000	9.000	12.125
2.5	6.250	14.000	11.000	17.250
3.0	9.375	12.000	13.000	22.375
3.5	12.500	10.000	15.000	27.500
4.0	15.625	8.000	17.000	32.625
4.5	18.750	6.000	19.000	37.750
5.0	21.875	4.000	21.000	42.875
5.5	25.000	2.000	23.000	48.000
6.0	28.125	0.000	25.000	53.125

[a]The symbols used in this table are as follows:

r = bill rate; Q_d = quantity demanded; Q_s = quantity supplied; $V - Q_s$ = quantity that holders wish to retain, and D = total demand is equal to $Q_d + V - Q_s$.

Demand schedule -- $r = 1.5 + .16Q$

Supply schedule -- $r = 6.0 - .25Q$

Stock of bills (V) -- 25 units

The equilibrium rate for the above equations is 3.256.

Behaviorally, this concept is more convenient than the Marshallian framework of Chart 8.

> As Wicksteed has argued, a division of the group into buyers and sellers for the purpose of drawing the demand schedules of the former and the supply schedules of the latter tends to confuse

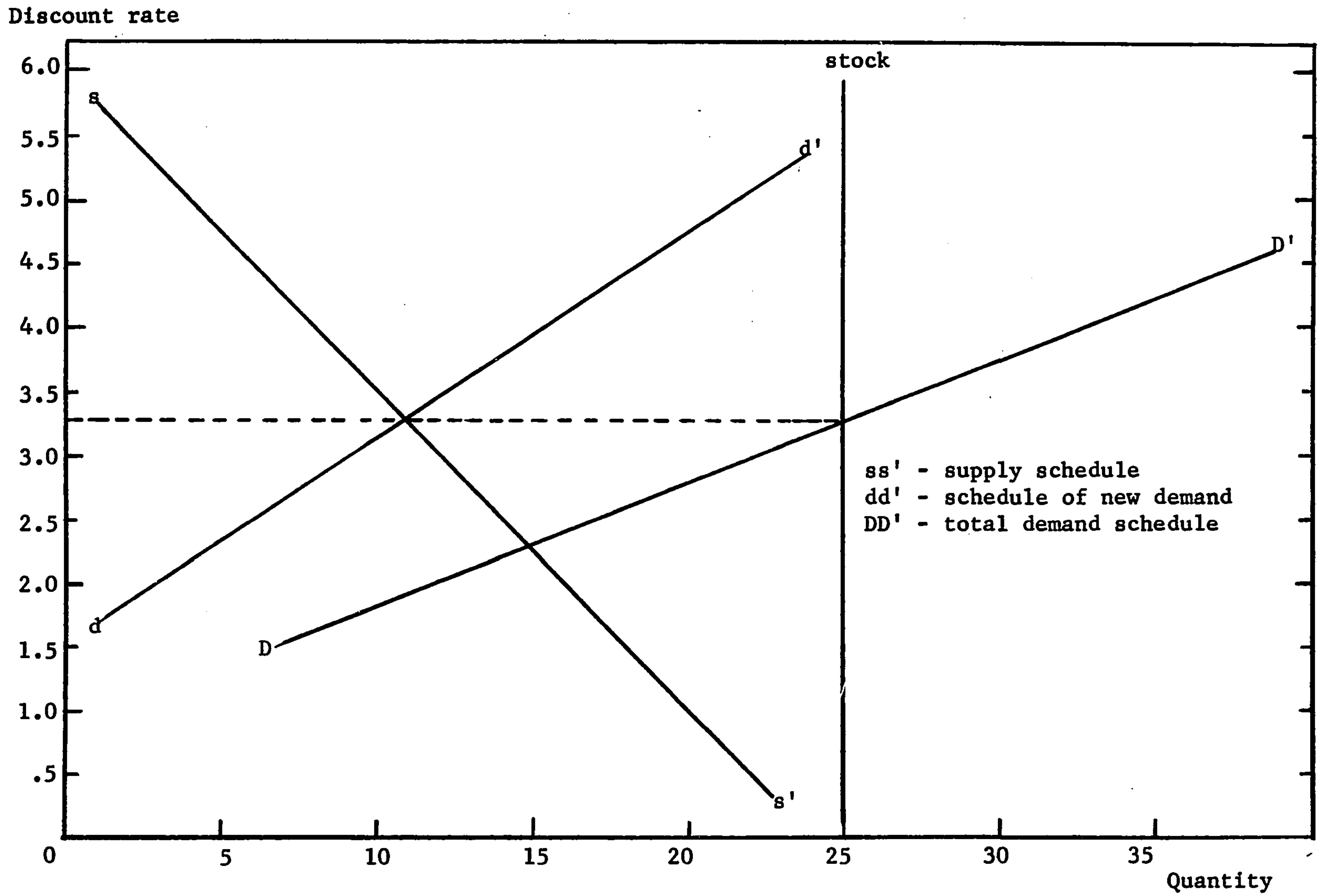

Chart 9.--Total demand schedule from Table 16.

the fundamental forces involved in the determination of equilibrium.[146]

Movements in the Equilibrium Rate

Treasury bills are traded in the secondary market through Government securities dealers. Trading also occurs in the primary market once each week as the Treasury sells directly through the auction. A flow diagram of primary and secondary market transactions is illustrated in Chart 10. This Chart pictures the Federal participants at the top of the diagram (the Treasury, Federal agencies and trust fund accounts, and the Federal Reserve System account), and the private sectors below (Government securities dealers, commercial banks, nonfinancial corporations, foreign governments and banks, state and local governments, and others). Arrows indicate the direction of movement of the bills.

Assuming that the stock of bills is defined as the total quantity of bills made available by the Treasury, less that quantity held by Federal agencies and trust funds and the Federal Reserve System; (*ceteris paribus*) the equilibrium rate will be increased as the stock is increased, and the equilibrium rate decreased as the stock is decreased.[147] Debt management and Federal Reserve open-market transactions therefore have a direct effect on the bill rate.

Assuming the stock is unchanging, (*ceteris paribus*) a "net" increase in demand for bills will decrease the equilibrium rate, while a

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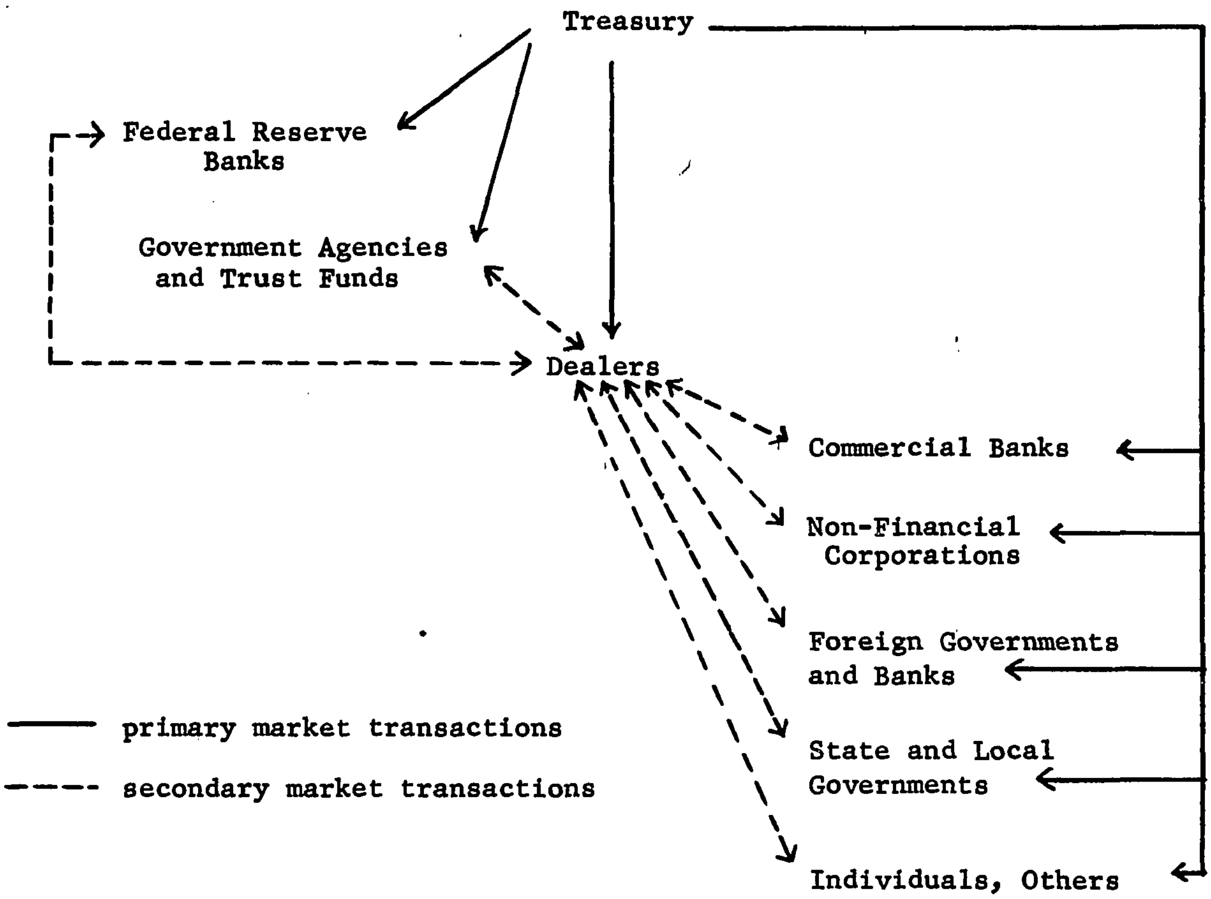
[146] Chase, *op. cit.*, p. 39.

[147] It should be pointed out that a change in the stock by a certain quantity shifts the original supply schedule as pictured in Chart 8 by the same quantity.



Note: Arrows indicate the direction of the transactions. At maturity, all bills are redeemed from the Treasury.

Chart 10.--Diagram of the trading of United States Treasury bills in the primary and the secondary market.

"net" decrease in demand will increase the equilibrium rate. By "net" change, it is intended that between two static periods, the quantity that all private sectors taken together desire to hold at various rates, increases or decreases.

Given the stock of Treasury bills available to the market, the total stock must be held by commercial banks, non-financial corporations, foreign governments and banks, state and local governments, or others. The equilibrium rate must adjust to the change in the total demand schedule.

The Nature of the Market

The validity of this simple model depends on a purely competitive market for bills, as well as the usual assumption of a large number of holders and traders of bills who behave as if they cannot influence the bill rate;[148] freedom of entry and exit of the market participants;[149] homogeneous product;[150] and perfect information on the part of buyers and sellers.[151]

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[148]The Treasury and the Federal Reserve System have the resources to influence the market, directly and indirectly. The above outline of the theoretical model assumed these participants to be operating on the stock of bills. Even though the rate can be shifted by trading activities, the quantities required to have any appreciable effect would be very large, the exact quantities for a particular change in the rate being dependent on the elasticity of the total demand schedule. For a discussion of the Treasury acting as a discriminating monopolist in the primary market, see: Andrew F. Brimmer, "Price Determination in the United States Treasury Bill Market," *The Review of Economics and Statistics*, Vol. XLIV (May, 1962), No. 2, pp. 178-183.

[149]Most participants are free to buy and sell bills at their fancy. Dealers, however, are faced with some problems of entry if it is their desire to become dealers recognized by the Federal Reserve Open Market Committee. The Open Market Committee only makes transactions through dealers which are recognized by the Committee. Since trading by the Federal

There is, however, a fair amount of disagreement as to how competitive the bill market actually is. R. S. Sayers has interpreted the United States market in Treasury bills as being a competitive one. In comparing the London bill market with the New York bill market, he stated: "The whole business is more complex than in London, and the greater heterogeneity of the New York market almost certainly makes for conditions closer to Marshall's perfect market."[152]

Conversely, Milton Friedman suspects that collusion exists among dealers in their bidding in the primary market.

> If you pay the price that you bid, then it really makes a great deal of difference that you should bid very close to the final price at which the auction is going to be settled.
>
> The only way to assure that you do so is to get together with other people and arrange your bids. As you may know, a similar method to the one we now use has been used in the British bill market and there you have explicit collusion. My understanding is that a single syndicate is formed which gets together and puts in a single bid.

Open Market Committee constitutes a large percentage of total transactions, being recognized is important to the financial success of a dealer. For a discussion of these points, see: "The Government's Management of its Monetary, Fiscal, and Debt Operations," Part 6B of Employment, Growth, and Price Levels, Hearings before the Joint Economic Committee of the Congress of the United States, August 5-7, 1959, Washington, 1959, pp. 1512-1517.

[150]Bills are not perfectly homogeneous in the sense that they do not have identical maturities. Bills of different maturities, from one to 52 weeks, are aggregated together. From the degree of association of their rate movements described in Chapter IV, it was assumed that they were similar enpugh to be treated as homogeneous.

[151]This requirement is probably as well satisfied as it could be. The participants in the bill market are probably as knowledgeable of the state of the market, movements of the rate, activity of other participants, and expected developments as any participants in any market.

[152]R. S. Sayers, Central Banking After Bagehot (Oxford: Oxford University Press, 1957), pp. 134-135. Also see: "The Government's Management of its Monetary, Fiscal, and Debt Management Operations," Part 6B, op. cit., pp. 1541-1545.

> I have no direct evidence on collusion in the United States, but I have examined the figures reported in the newspapers week by week on the minimum and maximum accepted bids under the auctions and I find it literally incredible that those bids are the result of wholly independent bidding by independent purchasers.[153]

If the dealers were simply providing a brokerage type service, that is arranging transactions between traders and taking a percentage of the transaction for their services, it seems that the assumptions of perfect competition would be more nearly satisfied. An example of this type of market is provided by Jaffé:

> The London silver market offers perhaps a clearer example than the stock exchange of a real market in which price determination most closely approximates the theoretical establishment of static equilibrium prices under competitive conditions. The functioning of this market has been described in the following terms: 'The London price is fixed once a day by four bullion firms which have for many years constituted the market. Representatives of these four firms meet at about 2 p.m. on weekdays and at 11 a.m. on Saturdays. All orders to sell or buy are placed with these brokers. They compare the orders, and the price is then fixed where it will move the greatest amount of "at market" orders. In short, the price is determined according to demand and supply. This is called "fixing" the price. As presumably the only interest of the brokers is the one-eighth of 1 per cent commission they make on purchases (there is no commission for selling silver) they have no interest in fixing the price at any but its economic level. Once determined, the price is immediately cabled to the banking centres of the world.'[154]

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[153] Testimony by Milton Friedman, "Constructive Suggestions for Reconciling and Simultaneously Obtaining the Three Objectives of Maximum Employment, An Adequate Rate of Growth, and Substantial Stability of the Price Level," Part 9A, Employment, Growth, and Price Levels, Hearings before the Joint Economic Committee of the Congress of the United States October 26-30, 1959, p. 3025. Also see: Milton Friedman, A Program for Monetary Stability (New York: Fordham University Press, 1959), pp. 64-65.

[154] William Jaffé, in translators notes of Léon Walrus, Elements of Economics (Homewood, Ill.: Richard D. Irwin, Inc., 1954), Lesson 6, Note 13, pp. 501-502. Jaffé is quoting from H. M. Bratter, "Silver--Some Fundamentals," Journal of Political Economy, Vol. XXXIX, No. 3 (June, 1931), pp. 362-363.

A similar situation prevails in the "daily fixing" of price in the London gold market. See: "The London Gold Market," Bank of England's

Since Government securities dealers are buying for their own account and selling out of their portfolios, it could be to their advantage to manipulate the market if they were able, either singly or as a group. No direct evidence is available that collusion exists in the primary market; and in fact, the criticism of Friedman's argument has been quite convincing.[155] Therefore, in the absence of evidence to the contrary, it is assumed in this study that the bill market is competitive enough that the model of pure competition can be usefully employed in analyzing changes in the bill rate.

The Nature of Equilibrium

In a market of this type, it would seem that the movement of the rate toward the equilibrium rate would be rapid. The shorter is the reaction time of the market participants to changes in the price of bills, the more rapid is the rate of adjustment toward a new equilibrium level.[156] Given the large volume of daily trading; the high degree of knowledge of the market by the participants; and the ease, speed, and low cost of making transactions due to the organization of the market; it would seem justifiable

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Quarterly Bulletin, March, 1964. An excerpt of this article appeared as a special supplement to the Federal Reserve Bank of New York Monthly Review, March, 1964.

[155] For an argument directed against the Friedman position regarding collusion, see: Henry N. Goldstein, "The Friedman Proposal for Auctioning Treasury Bills," The Journal of Political Economy, Vol. LXX, No. 4 (August, 1962), pp. 368-392. Also, see: William Rieber, "Collusion in the Auction Market for Treasury Bills," pp. 502-512; Friedman, "Comment," pp. 513-514, and Rieber, "Rejoinder," p. 515; The Journal of Political Economy, Vol. LXXII, No. 5 (October, 1964). Also Rieber's unpublished dissertation (Massachusetts Institute of Technology, 1963) The Primary Market for United States Treasury Bills.

[156] Schneider, Pricing and Equilibrium, op. cit., pp. 247-250.

to assume that reaction by all dealers, most large banks, and many non-financial corporations would be almost instantaneous. On the basis of the description in Chapter II, of the market behavior of economic sectors, it will be assumed that the reaction time of the market participants would be rapid relative to other types of markets. In addition, the existence of a periodic weekly seasonal factor, indicates that the adjustment period is short. Given the volatility of the bill rate, one of two alternative separate conclusions could be reached: (a) the adjustment toward equilibrium is instantaneous with each and every transaction taking place at an equilibrium level, or (b), the bill rate never reaches a true equilibrium position due to the rapidity with which changes in market conditions are taking place. Since a choice between these relatively "pure" alternatives would be conjectural, a "middle" position would be more consistent with the above discussion. Considering the nature of the market and the conclusions and assumptions that have been considered, it will be sufficient to assume that the participants' reactions to changes in market data cause the bill rate to move instantaneously toward a new equilibrium level, but the actual changes in market data occur so rapidly and consistently that even if the bill rate achieved an equilibrium level, it will not remain fixed for any significant period of time.[157]

Although time has not been specifically discussed, it has been implicitly an important consideration throughout the discussion of equilibrium. Schneider has pointed out the shortcomings of an analysis based purely on comparative-static hypothesis.

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[157] "Stable" in the sense is assumed to mean absolutely rigid and unchanging.

> The answer to the question as to how the equilibrium values vary with changes in data is of fundamental importance. To find out that a particular set of data corresponds to a particular equilibrium position is by itself quite inadequate. Equilibrium analysis only achieves real value by studying how changes in data influence the equilibrium values.[158]

Paul Samuelson has stressed the importance of the dynamic view in equilibrium analysis.

> It is the task of comparative statics to show the determination of the equilibrium values of given variables (unknowns) under postulated conditions (functional relationships) with various data (parameters) being specified. Thus, in the simplest case of a partial-equilibrium market for a single commodity, the two independent relations of supply and demand, each drawn up with other prices and institutional data being taken as given, determine by their intersection the equilibrium quantities of the unknown price and quantity sold. If no more than this could be said, the economist would be truly vulnerable to the gibe that he is only a parrot taught to say 'supply and demand'. Simply to know that there are efficacious 'laws' determining equilibrium tells us nothing of the character of these laws. In order for the analysis to be useful it must provide information concerning the way in which our equilibrium quantities will change as a result of changes in the parameters taken in independent data.[159]

Since this study of the bill rate is really a study in the movement of the series over time, some hypothesis of the way the relevant variables and parameters interact over time is necessary.

Dynamic Considerations

Samuelson has defined a system as dynamical "if its behavior over time is determined by functional equations in which 'variables at different points of time' are involved in an 'essential' way."[160] Any attempt to

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[158] Schneider, Pricing and Equilibrium, op. cit., p. 243.

[159] Paul A. Samuelson, Foundations of Economic Analysis (Cambridge: Harvard University Press, 1947), p. 257.

[160] Ibid., p. 314.

explain the movement of the bill rate must be concerned with hypotheses in addition to those derived from the comparative-static framework. Indeed, it has been pointed out that even with a comparative-static model of market behavior, there are implicit dynamic considerations.

> A large part of the empirical literature--demand analysis, in particular--has as its object the estimation of functions given by comparative static economic theory. Such analysis has its conceptual difficulties, however. Even the functions of static theory must have, in reality if not in abstraction, a time dimension. It is, after all, not permissible to speak of an estimated demand reaction without some specification, at least implicit, of the time period in which that reaction is supposed to take place. A time series estimate of a static function is a snapshot taken of the dependent variable in a dynamic reaction at a given moment in time. If that snapshot is taken ten minutes after a change in an independent variable, we are likely to get quite a different picture from the snapshot taken a year later or from the final photograph in the series taken at the time (if it ever comes) when all reaction has ceased and equilibrium has been finally re-established.
>
> It is thus of some importance in any empirical investigation of this type to consider which of such a series of snapshots one wishes to develop. Such consideration has important consequences for the kind of data chosen and for the way in which those data are utilized. Carelessness here can be fatal, for it may lead to mixing of two reactions, to a sort of double exposure.
>
> Put somewhat more generally: the specification and estimation of any static economic reaction always involves the construction of an implicit dynamic model.[161]

In a comparative-static theoretical framework, the actual values of the variables are important, while in a dynamic theoretical framework, concentration is centered on the changes in the values of the variables from one time period to the next, once the appropriate lags in the relevant independent variables have been taken into account. For instance, a sale of bills by the Federal Reserve Open Market Account should have the

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[161]Franklin M. Fisher, A Priori Information and Time Series Analysis: Essays in Economic Theory and Measurement (Amsterdam: North-Holland Publishing Co., 1962), pp. 21-22.

instantaneous effect (<u>ceteris paribus</u>) of increasing the bill rate. Nevertheless, it is evident that the <u>ceteris paribus</u> assumption will not be satisfied if one of the basic tenants of monetary policy, namely, that there are lagged responses to open market operations, is valid. A sale by the Federal Reserve System is assumed to initiate changes in bank reserves and the money supply that in turn bring about changes in the plans of other sectors to hold bills in subsequent time periods. Therefore, if the Federal Reserve System sells, there will be a decrease in the bill rate in the current period, plus additional effects on the level of the rate in subsequent periods brought about by resulting lagged changes in other relevant independent variables.

The time period that has been chosen for observing changes in the variables is one month. The change in the bill rate, for instance, will be measured as the difference between the level of the rate at the end of the current month and the level of the rate at the end of the month immediately preceding. The same measurement will apply for the other independent variables.

Using first differences also yields some important dividends from the statistical point of view. It was pointed out at the beginning of this study that observations of the values of these variables taken at such short intervals would probably yield a high degree of autocorrelation and/or multicollinearity. Some advantages of working with first differences when faced with these problems are discussed by Fisher.

> The primary devise for the estimation of short-run reaction is the use of first differences of the data. Aside from the fact that such use often (but by no means always) has the convenience of reducing or eliminating autocorrelation in the residuals, or reducing multicollinearity, it seems analytically the correct form for the estimation of

> short-run functions. The use of absolutes for estimation purposes must necessarily involve a complete specification of the time structure of the model, and of the variables thereof, including long-run as well as short-run elements. The use of first differences, however, enables us approximately to isolate the short-run elements since we may assume the long-run components of the reaction to be relatively constant during the interval over which first differences, are taken. This is frequently of considerable advantage since we need not specify the precise form that the long-run elements take. It is thus often possible to use first differences to obtain estimates of short-run influences that are not dependent on the precise form of our long-run assumptions.[162]

The choice of the appropriate time period for the empirical analysis is crucial. In a study of the short-run determinants of the Treasury bill rate, the average yearly rate relative to the independent variables, measured on a yearly basis, would simply average out short-run movements. The bill rate fluctuates daily (or even hourly), but it would not be meaningful to explain these movements, even if it were possible to do so. In a short-run analysis of the bill market, a logical choice of the time period would be either weekly, monthly, or quarterly. Fisher provides some considerations that are important in choosing the time period.

> ...it is important to realize that these interpretations of the first difference procedure implicitly assume that the interval over which the differences are taken is long enough so that the reaction over the interval is of interest. This is not so trival as it may appear. The prevailing practive of automatically removing trends by first differences or other means may often lead to the estimation of reaction that are so short-run as to be of little or no concequence. (Of

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[162] *Ibid.*, pp. 22-23. Also see: D. Cochrane and G. H. Orcutt, "Application of Least Squares Regression to Relationships Containing Auto-Correlated Error Terms," *Journal of the American Statistical Association* (March, 1949), Vol. 44, No. 245, pp. 32-61; and Daniel B. Suits, "The Determinants of Consumer Expenditure: A Review of Present Knowledge," *Impacts of Monetary Policy* (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1963), pp. 32-39.

> course, the failure so to remove trends to any extent may lead to the estimation of reactions that are so long-run as to be also of little interest.) If data are gathered weekly, say, first differencing in the ordinary way will have meaning only if one thinks the reaction in question takes place fast enough so that the dependent variable responds visibly to week-to-week changes in the independent variables. Clearly, if data were gathered often enough, there would be no point in first differencing, since the absolute data themselves would reflect short-run perturbations. Moreover, many economic reactions take place relatively slowly, so that, even if data were gathered only on a yearly basis, first differences would involve only a short-run part of a long-run reaction.[163]

In the preceding discussion of the speed of movement toward equilibrium, it was contended that reactions by the market participants to changes in market data were virtually instantaneous, and that the use of very short time periods should yield valid, interesting results. This contention may be shown to be invalid by the empirical estimations of Chapter VIII. Nevertheless, since evidence has been shown that a definite monthly seasonal pattern exists in bill rate movements (and strong indications were shown of a weekly pattern), the shortest possible time period should be used. Given the data available for explanatory variables, the monthly time period, partially by default, becomes the time period for analysis. It is further hypothesized that the causes of the monthly seasonal, cyclical, and irregular movements in the bill rate can be determined within a simply dynamical supply and demand framework.

A Discussion of Statistical Techniques

It was argued above that, on *a priori* grounds, the use of first differences of the variables, instead of levels, might be more meaningful in the economic sense. It was also suggested that the use of first differences might be more satisfactory in the statistical sense.

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[163] Fisher, *op. cit.*, p. 24.

The level of the Treasury bill rate, as the dependent variable, will be correlated initially with levels of various independent variables. Also, initially, no lags will be assumed.[164] Since time series with observations taken at relatively short intervals make up the data, it should be suspected that autocorrelation of residuals may result. In the simple linear model

(1) $Y_t = a + bX_t + u_t$

(where Y_t is the dependent variable, X_t is the independent variable, u_t is the disturbance term in time period t, and u_s is the disturbance term in time period t-n; with t = 1, 2, ...n) independence of the u_t requires that:

(2) $E(u_s u_t) = 0$, for all $s \neq t$;

where E denotes the expected value. If

$$E(u_s u_t) \neq 0,$$

then the u_t's are not serially independent, and autocorrelation exists.[165] Autocorrelation does not bias the estimation of the regression coefficients, but results in a bias of the variance of the regression coefficients and the residual variance.

A test for the serial independence of the residuals is available in the Durbin-Watson statistic (d):[166]

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[164] Although using the bill rate in the form of the "monthly average of daily closing rates," while the independent variables are in the form of levels at the end of the month implies some short lag.

[165] J. Johnston, Econometric Methods (New York: McGraw-Hill Book Co., Inc., 1963), pp. 9, 177-192; Arthur S. Goldberger, Econometric Theory, (New York: John Wiley and Sons, 1964), pp. 231-238; and Lawrence R. Klein, A Textbook of Econometrics (Evanston, Ill.: Row, Peterson and Co., 1953), pp. 80-92.

[166] J. Durbin and G. S. Watson, "Testing for Serial Correlation in Least Squares Regression. II," Biometrika, Vol. 38, Parts 1 and 2 (June, 1951), pp. 159-178.

$$(3) \qquad d = \frac{\sum_{t=2}^{n} (u_t - u_{t-1})^2}{\sum_{t=1}^{n} u_t^2}.$$

The calculated values for d, and (4 - d) are then compared with upper and lower bounds (d_u and d_L) in a one-sided test for positive autocorrelation of the residuals.

If it is not possible to accept the hypothesis of random disturbances, that is, if the residuals appear to be positively correlated, assumptions may be made regarding the form of the autocorrelation of the residuals; the simplest case being the first-order autoregressive structure where:

$$(4) \qquad u_t = (\rho)u_{t-1} + e$$

ρ may be estimated by r in the equation:[167]

$$(5) \qquad r = \frac{\sum_{t=2}^{n} u_t u_{t-1}}{\sum_{t=2}^{n} u_t^2},$$

and this estimate of ρ is used to transform the dependent variable and the independent variable(s) by:

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[167] Johnston, *op. cit.*, pp. 195-199. It has also been shown that r is closely approximated by the formula

$$\frac{T^2(1-.5d') + V^2}{T^2 - V^2}$$

where T is the number of observations, V the number of variables (or constants), and d' the calculated Durbin-Watson statistic: see H. Theil and A. L. Nagar, "Testing the Independence of Regression Disturbances," *Journal of the American Statistical Association*, Vol. 56, No. 296 (December, 1961), pp. 793-806.

(6) $Y_t - rY_{t-1} = Y_t'$

and $X_{it} - rX_{it-1} = X_{it}'$, (*i* denotes the number of the independent variable, i = 1, 2, ...n) and regressing Y_t' on X_{it}' in order to estimate the regression coefficients (b_i). In order to state the relationship in the form of original variables, the constant *a'* is equal to the original constant *a*, multiplied by (1-r), therefore:[168]

(7) $Y_t' = a + b_i'X_{it}'$

(8) $Y_t = a(1-r) + b_i'X_{it}$

(9) $Y_t = a' + b_i'X_{it}$.

Now if ρ is equal to unity, the transformation of the original variables is:

(10) $Y_t' = Y_t - \rho Y_{t-1}$ or, $Y_t - Y_{t-1}$

$X_{it}' = X_{it} - \rho X_{it-1}$ or, $X_{it} - X_{it-1}$

indicating that a proper method for estimating the regression coefficients would be to fit linear relationships in the form of first differences. Therefore, the Durbin-Watson statistic and the autocorrelation coefficient are calculated and reported in most of the following regression calculations.

When ρ is equal to, or near, the value 1, all variance estimates--and therefore all *t* tests and *F* tests--when levels of the variables are used are meaningless. Standard errors and coefficients of determination for the estimates using levels are reported solely for the subjective evaluation of the "goodness" of fit. Variance estimates using transformed variables will be nearer to true variance estimates and are more meaningful;

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[168] Johnston, *op. cit.*, pp. 195-199.

however, it must be remembered that ρ is only estimated by r, and the true variances are unknown.[169]

When ρ is unity, the regression coefficient from the first difference equations is an estimate of the parameter in the same sense as the regression coefficient calculated using levels.[170] The correspondence between the regression equation using levels of the variables and the equation using first differences--when ρ is unity may be illustrated by substitution into equation (1):

$$(11) \quad Y_t - \rho Y_{t-1} = a(1-\rho) + b(X_t - \rho X_{t-1}) + (u_t - \rho u_{t-1}),$$

and using equation (10), since ρ is equal to 1:

$$(12) \quad Y_t - Y_{t-1} = b(X_t - X_{t-1}) + (u_t - u_{t-1}),$$

and

$$(13) \quad \dot{Y} = b\dot{X} + v$$

where the dot over the variable indicates successive differences and v is a new disturbance term approximating $(u_t - u_{t-1})$.

However, if a first difference linear regression equation is estimated and the constant is not zero, how should the constant be interpreted? In a recent empirical study, Suits has commented that; "...the constant term...in a first difference equation measures the trend...."[171] Also in

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[169] Another procedure is to assume different values for ρ and by iterative procedures deduce the r that comes nearest causing the summation of the $u_t u_{t-1}$ to equal zero, and use this value to transform the original variables. This approach is used in Clifford Hildreth and John Y. Lu, Demand Relations with Autocorrelated Disturbances, Technical Bulletin 276, Department of Agricultural Economics, Michigan State University (November, 1960). I wish to thank T. D. Wallace for pointing this out, and for discussion on this point.

[170] "Although the estimate of the regression coefficient from levels of variables will be unbiased if autocorrelation exists, the estimates will be inefficient because of the needlessly large sampling variances." Johnston, op. cit., p. 179.

[171] Daniel B. Suits, "The Determinants of Consumer Expenditure: A Review of Present Knowledge," Impacts of Monetary Policy (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1963), p. 34.

an empirical context, Karaken and Solow have said; "As is well known, a negative constant in a first-difference regression corresponds to a negative linear trend in the absolute variables."[172] It is not easy to reconcile these two statements, and it is argued below that neither statement is generally true. Using a linear relationship as above, but including time as a variable,

$$(14) \quad Y_t = a + bX_t + ct + u_t.$$

If ρ is equal to one, then transformation, from equation (10), would yield

$$(15) \quad Y_t - Y_{t-1} = b(X_t - X_{t-1}) + ct + v,$$

and since t = 1 in a first-order scheme,

$$(16) \quad \dot{Y} = c + b\dot{X} + v.$$

Therefore, the regression coefficient <u>c</u> measures "trend," but <u>only</u> when $\rho = 1$. The trend measured here is the trend in the dependent variable--but this is true <u>only</u> if there is no trend in X. Use of the first equation of the two normal equations for the two-variable case, where the variables are first differences, ($\dot{X}$):

$$(17) \quad \Sigma\dot{Y} = na + b\Sigma\dot{X}$$

and division by the number of observations yields,

$$(18) \quad \bar{\dot{Y}} = a + b\bar{\dot{X}}.$$

If there is no trend in the level of a variable, the expected value of the first differences is:

$$(19) \quad \begin{aligned} &E(\Sigma\dot{Y}) = 0,\ E(\Sigma\dot{X}) = 0 \text{ and} \\ &E(\bar{\dot{Y}}) = 0,\ E(\bar{\dot{X}}) = 0. \end{aligned}$$

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[172] John Karaken and Robert M. Solow, "Lags in Monetary Policy," <u>Stabilization Policies</u> (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1963), p. 50.

If there is a positive trend, the above expected values will be positive; if there is a negative trend, there will be negative expected values. A few special cases are discussed for purposes of illustration.

Consider first a positive (or negative) trend in the level of the dependent variable and no trend in the independent variable: $E(\Sigma\dot{Y}) \neq 0$, $E(\Sigma\dot{X}) = 0$. Substitution into equation (17) yields, since $\Sigma\dot{X} = 0$,

$$\Sigma Y = na, \text{ and, therefore}$$

$$\bar{\dot{Y}} = a.$$

This, indeed, does measure the trend in the dependent variable, which could be described verbally as the average change per time period in the absolute level of the dependent variable.

Second, consider the case of no trend in the dependent variable, but a positive (or negative) trend in the independent variable: $E(\Sigma\dot{Y}) = 0$, $E(\Sigma\dot{X}) \neq 0$. Again, substitution into equation (17) yields, since $\Sigma\dot{Y} = 0$,

$$na = b\Sigma\dot{X},$$

$$a = b\,\frac{\Sigma\dot{X}}{n}, \text{ and}$$

$$a = b\bar{\dot{X}},$$

the value of which depends on the trend in $\underline{X}$ and the $\underline{b}$ value, the slope of the relationship between $\underline{\dot{Y}}$ and $\underline{\dot{X}}$.

Finally, with a trend in both $\underline{Y}$ and $\underline{X}$, substitution into equation (17) yields:

$$na = \Sigma\dot{Y} - b\Sigma\dot{X}, \text{ and}$$

$$a = \bar{\dot{Y}} - b\bar{\dot{X}}.$$

The meaning of $\underline{a}$ in this situation depends on the relative trend of $\underline{Y}$, and the trend of $\underline{X}$ times $\underline{b}$. As a single value, the $\underline{a}$ value in this situation is nebulous. If the $\underline{b}$ value were zero, it would measure the trend of $\underline{Y}$, and if b were 1 it would measure the difference in the average monthly trend between X and Y, $(\dot{\bar{Y}} - \dot{\bar{X}})$. However, unless the trend of these variables is already known, the computed constant in a first difference equation provides few insights, even in simple linear regression. The problem in interpreting the meaning of the constant when using first differences in a multiple regression situation is obvious. If ρ were 1, the value of the constant should be zero. But if the calculated constant is not zero, what meaning should be attached to the constant? In those situations where it is felt, on *a priori* grounds that the value of the constant should be zero in a first difference correlation, the regression coefficient may be calculated by:

$$(20) \qquad b = \frac{\Sigma \dot{X}\dot{Y}}{\Sigma \dot{X}^2}$$

which forces the regression line through the origin.[173]

In addition to fitting regression equations using levels and their successive differences, some equations are calculated using logarithmic (natural) transformations of the levels of the variables. The regressions using logarithmic transformation of the levels provides information on the form of the functional relationships. Also if it seems appropriate on theoretical grounds, some variables may be included with a one period lag.

Finally, most of the actual calculations are done on an electronic computer utilizing programs written specifically for this analysis. The principal program is patterned on the calculation procedures of Joan Friedman and Richard J. Foote, who utilize a modified forward Doolittle

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[173] *Ibid.*

technique.[174] The derivation of the Durbin-Watson statistic, the autocorrelation coefficient, and the residuals are carried out in a separate series of calculations. In all cases, the programs have been thoroughly checked and tested to minimize any computational errors--especially round-off errors which can cause significant loss of accuracy in the inversion of the matrices.

Summary and Conclusions

It has been argued in this Chapter that a comparative-static partial-equilibrium analysis, the assumption of pure competition, and the use of Wicksteed's total demand concept with the total supply of bills considered as a stock provide an appropriate tentative framework for an explanation of the determinants of the Treasury bill rate.

According to the discussion thus far, monthly changes in the bill rate will be brought about by either a change in the stock of bills (due to Treasury or Federal Reserve System debt management decisions) available in the economy, or by changes in the demand for bills by bill-holders. In Chapter VI, the factors determining the stock of bills as determined by Treasury debt management and Federal Reserve System monetary policy will be examined in greater detail.

The time period for viewing the relationships between the bill rate and "independent" variables is taken as one month. The reasons for this decision are: (1) bill rate movements over monthly periods show some regularity and seemingly are important, and (2) although rate

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[174] Joan Friedman and Richard J. Foote, Computational Methods for Handling Systems of Simultaneous Equations, Agriculture Handbook No. 94, (United States Department of Agriculture, November, 1955).

movements over shorter periods may be interesting, sufficient data for the independent variables is unavailable. Whether the observations should be taken as levels or successive differences should not be decided on *a priori* grounds and both will be experimented with.

The statistical problem of positive autocorrelation of the residuals was investigated relative to whether levels or successive differences are used as variables, and the method of attempting to eliminate biases from autocorrelation by transformation has been explained.

CHAPTER VI

DEBT MANAGEMENT, OPEN MARKET OPERATIONS, AND THE SUPPLY OF TREASURY BILLS

Introduction

In the simple theoretical framework just discussed, the quantity of bills outstanding was viewed as a stock, and bill rate equilibrium was indicated by the intersection of the total demand schedule with this stock. The stock of bills was defined as the total quantity made available by the Treasury less holdings by Federal agencies and trust funds and the Federal Reserve System. The purpose of this Chapter is to examine the movements in the stock of bills due to Treasury and Federal Reserve System operations.

These policy operations could be classified generally as "debt management,"[175] combining the debt activities of the Treasury and the Federal Reserve System. The definition of debt management used in this study

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[175]Smith, *op. cit.*, p. 2, has formulated a widely quoted definition as: "...define debt management to include all actions of the Government, including both the Treasury and the Federal Reserve, which affect the composition of the publicly held debt. When defined in this way, debt management includes: (1) decisions by the Treasury concerning the types of debt to be issued to raise new money, (2) decisions by the Treasury concerning the types of debt to be issued in connection with the refunding of maturing securities, (3) decisions by the Federal Reserve concerning the types of debt to be purchased and sold in the conduct of open market operations."

include: (1) Treasury decisions concerning the maturity structure and types of debt instruments constituting the existing Federal debt, (2) Treasury decisions concerning the types of Federal debt instruments held in the portfolios of the various Federal agencies and trust funds, and (3) Federal Reserve System decisions concerning the types and quantities of Government securities traded in the open market. This definition does not include fiscal policy decisions concerning the size of the Federal debt, or monetary policy decisions relating to required reserve ratios and rediscount rates.[176] Debt management, thus defined, includes the policy operations of: Treasury debt management, Treasury open market transactions,[177] and Federal Reserve System open market transactions. These

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[176] Smith has also provided an alternate definition as: "...it includes all measures that affect the size and composition of the stock of outstanding claims against the Federal Government (including the Federal Reserve System). On this definition, debt management would encompass all cash borrowing, debt retirement, and refunding operations of the Treasury, and all open market operations of the Federal Reserve System...the only measures left under the heading of monetary policy would be changes in member bank reserve requirements and in the discount rate." Changes in the stock of bills under the definition in the text fall midway between these two definitions by Smith. Ibid., p. 27.

For some other definitions of debt management, see: Thomas R. Beard, "Debt Management: Its Relationship to Monetary Policy, 1951-1962," The National Banking Review, Vol. 2, No. 1 (September, 1964), pp. 61-76; Richard A. Musgrave, The Theory of Public Finance (New York: McGraw-Hill, Book Co., Inc., 1959), pp. 581-611; Earl R. Rolph, "Principles of Debt Management," The American Economic Review, Vol. XLVII, No. 3 (June, 1957), pp. 302-320; James Tobin, "An Essay on Principles of Debt Management," Fiscal and Debt Management Policies (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1963), pp. 143-218; and O. H. Brownlee and I. O. Scott, "Utility, Liquidity, and Debt Management," Econometrica, Vol. 31, No. 3 (July, 1963), pp. 349-362.

[177] For the details of the Treasury conduct of transactions for Government agencies and trust funds, see: W. Nelson Peach, "Treasury Investment Funds and Open-Market Operations," The Journal of Finance, Vol. VI, No. 1 (March, 1951), pp. 46-53; and Deane Carson, "Treasury Open Market Operations," The Review of Economics and Statistics, Vol. XLI, No. 4 (November, 1959), pp. 438-442.

policy operations determine the stock of Treasury bills available for the public to hold.[178]

However, it is not absolutely necessary to include Federal Reserve System open market transactions as changing the stock of bills.[179] The System could be viewed as easily as entering the market as a demander and aggregated into the total demand schedule, allowing all bill stock changes to be determined by Treasury debt management operations. This procedure would allow separation of Treasury and Federal Reserve operations in the bill market in graphical illustrations, but would help little conceptually.

If the bill rate were an important variable in determining the quantity of bills the System desired to hold, it would be appropriate to include the Federal Reserve System as acting through the total demand schedule instead of through stock changes. It seems, however, that the principal purpose of Federal Reserve System open market operations is aimed at affecting the level of member bank reserves. The Federal Reserve System does not enter the market for the purpose of attempting to earn any interest return, and does not behave, therefore, in the same fashion as other holders of bills.

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[178] For an example of the meaning of publicly held debt, see: Thomas R. Beard, "Money, Liquidity, and the National Debt," Nebraska Journal of Economics and Business, Vol. 3, No. 1 (Spring, 1964), p. 48. "It has become customary in recent years to compute the 'publicly held' national debt. This measure excludes Treasury debt held by U. S. Government agencies and trust funds and by Federal Reserve Banks. 'Publicly held' national debt provides a better measure of assets to the non-Federal government sector, but includes holdings by state and local governments and foreign and international accounts."

[179] Schneider, Money, Income, and Employment, op. cit., p. 74. Schneider illustrates purchases on the total demand schedule and sales as stock movements.

For the great majority of Federal Reserve System open market bill transactions, the bill rate is not an influential determinant of the quantities of bills to be bought or sold. It seems logical to make the assumption that the behavior of the Federal Reserve System, like that of the Treasury, is basically exogenous to the bill market. The advantage of including Federal Reserve System transactions with Treasury debt management operations is that the behavior of the non-governmental market participants is represented by the total demand schedule.

Up to this point, the stock of bills has provided a useful and simple conceptual framework for examining the bill rate and the quantity of bills. Now, however, it is necessary to examine, in some detail, whether the use of the stock concept is appropriate for this analysis. More specifically, is it accurate to state bill market behavioral relationships in terms of stocks, or should these relationships be stated in terms of flows?

Stocks Versus Flows

Very generally, a stock is considered to be a relatively fixed quantity at a given time, while a flow is thought of as a quantity steadily changing over time. Generally, wealth is considered a stock, income a flow; capital a stock and investment a flow. Money is usually considered to be an existing stock, and when the flow of transactions out of this stock are considered, the concept of velocity becomes relevent.[180] For

[180]For some analogies of stocks and flows, see: Conard, *op. cit.*, p. 218; and G. L. S. Shackle, "Recent Theories Concerning the Nature and Role of Interest," *The Economic Journal*, Vol. LXXI, No. 282 (June, 1961), pp. 209-254.

most purposes it seems that the supply of U. S. Treasury bills fits this general concept of a stock, being generally like wealth, capital, or the stock of money.

A simple comparative-static theoretical framework has been described using the stock of Treasury bills available to the public as the supply. Most of the available statistical data relate to quantities outstanding, or quantities held by economic sectors, at the end of the month. Intuitively, it seems reasonable to view these values as stocks.

In the majority of the months in this period, the changes in the stock by the Treasury and Federal Reserve System are small relative to the total quantity of bills.[181] But again, this is a relative matter--the addition to the stocks of automobiles is small relative to the existing stock, but automobile production seems better described as a flow. The problem here is the attempt to formulate an operationally useful framework that is as consistent as possible with conceptual theoretical arguments. For many of the bill market participants, the only data available are end-of-month holdings, with little knowledge of the movement of these holdings within the month.[182] Taking the Federal Reserve System Account as an example, the difference in bill holdings between two consecutive end-of-month periods is simply the <u>net change</u> in holdings in that particular month. For Federal Reserve System holdings, data are available for

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[181] There are some extreme movements which should be noted. Within the one-month period, the stock of bills has changed, due to Treasury action, by as much as ten per cent of the total quantity. Also, within a month, the Federal Reserve System, has changed their <u>net</u> holdings by as much as five per cent of the total Treasury stock.

[182] See Chapter II above for the discussion of the statistical data relating to holdings by various groups.

the total purchases and total sales of bills for the month--but even this provides no information regarding the time during the month that any of these transactions took place.

In order to make use of the available statistical data, it is necessary to view the level of bills issued by the Treasury, the level of Federal Reserve System holdings, and the level of bills held by each sector, as of the end-of-month periods. Since it was decided in Chapter V that monthly changes in the levels of the variables could be appropriate for statistical purposes, it might be argued that this would cast all relationships as flows--but first differences do not necessarily measure flows. The nature of the statistical data necessitates using these end-of-month quantities and monthly changes in quantities, whether or not the stock concept and the total demand schedule are theoretically justified. By including the Federal Reserve System holdings in the stock of bills, monetary policy through bill transactions and debt management through issues of bills can be separated from the demand by public holders and changes in demand brought about through changes in the stock.

Nevertheless, on the macroeconomic level, the stock versus flow problem is important in the theory of interest rate determination. The demand and supply of money versus the demand and supply of securities, and the loanable-funds versus the liquidity-preference controversies have revolved around whether variables should be treated as stocks or flows.[183]

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[183]The literature on this problem is voluminous, and there is little indication that the controversy is settled. For surveys of the problem, see: Shackle, op. cit., and Harry G. Johnson, "Monetary Theory and Policy," The American Economic Review, Vol. LII, No. 3 (June, 1962), pp. 335-384.

No attempt will be made here to go into very much detail regarding the macroeconomic aspects of the problem, but it seems necessary to investigate the relevance, at the microeconomic level, of the stock-flow discussion to the quantity of bills.

At any particular point in time, the quantity of U. S. Treasury bills or the quantity of Federal debt is a fixed amount, a stock. The gross marketable debt of the Treasury as of December 31, 1961 was approximately $196 billion, and the quantity of U. S. Treasury bills issued by the Treasury was approximately $43.4 billion. But, it can be argued that the quantity of <u>any</u> commodity at a particular point of time is a fixed amount. The Marshallian "market period" is defined as a period so short that supply is fixed and can be treated as a stock. However, in this study of the bill market, a time period of one month is too long to be considered a "market period" since the total quantity of bills available to the public can, and does, change. Open market transactions take place almost continuously, and the Treasury has the opportunity to change the quantity of bills at each weekly auction. The quantity of bills available to the public is not absolutely fixed, but then neither is the quantity of capital or money.

In a discussion of whether a stock or flow theory is appropriate to the market for "securities," Shackle has commented that:

> The contrast, we may interpolate, is between a market such as that for electricity or fresh milk, where what is demanded from moment to moment or from day to day, and a market such as that for antique furniture, where supply is an existing and non-augmental quantity existing at all times. The market for securities is evidently nearer to the antique furniture than the electricity end of the scale.[184]

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[184] Shackle, <u>op</u>. <u>cit</u>., p. 222.

Although Shackle is referring to the securities market in a macroeconomic sense, the analogy seems relevant to the market for Treasury bills--except that, unlike antique furniture, the supply of bills is an augmentable quantity under our stock definition. As Shackle points out, this classification of the securities market is relative, and he feels this market is *more* adequately described in stock terms than flow terms.

Conard has pointed out that in attempting to classify a market as described by stock or flow variables, concepts are not nearly as important as the theoretical considerations.

> Brunner and Klein would say that one does not create a flow theory merely by using flow concepts. A flow theory would have to assume that ultimate behavioral patterns are defined in terms of flows.[185]

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[185] Conard, *op. cit.*, p. 219. In order to provide some indication of the extent of agreement on this point in practice, the following examples are cited.

James S. Duesenberry has formulated an argument in terms of flows to explain equilibrium rate movements in the securities market, and James Tobin has commented that: "The supply and demand functions for financial assets, which occupy the central place in Duesenberry's model, should be stated in terms of *stocks* as well as *flows*. The basic behavior behind the flow of funds is the adjustment of the balance sheets, or portfolios, of individuals, business firms, and financial enterprises toward a desired allocation of wealth among holdings of various assets and debts. In this adjustment, the basic decision variables are stocks; and flows will be dominated by attempts to adjust stocks to changes in total wealth, interest rates, and other determinants." (James S. Duesenberry, "A Process Approach of Flow-of-Funds Analysis," pp. 173-189, and James Tobin, "Comment," pp. 190-193; in *The Flow-of-Funds Approach to Social Accounting*, National Bureau of Economic Research Studies in Income and Wealth, Vol. 26, Princeton, N. J.: Princeton University Press, 1962). A similar criticism is made by John H. Kareken in a review of Gaines' *Techniques of Treasury Debt Management* (op. cit.), in *The Quarterly Review of Economics and Business*, Vol. 3, No. 1 (Spring, 1963), pp. 103-105. On the other hand, Brian Tew in a review of Turvey's *Interest Rates and Asset Prices* (*op. cit.*), criticizes Turvey for formulating his model of the market for U. S. Government securities in terms of *stocks* instead of *flows*, *Economica*, Vol. XXVII, No. 112 (November, 1961), pp. 427-431. These comments illustrate that differences of opinion still exist in the stock-flow definitions. These problems as related to this study, are not crucial for statistical estimation, but may necessarily qualify the interpretation of some of the results.

Although it is difficult to attribute behavioral patterns to the Treasury in its debt management operations or to the Federal Reserve System in its open market operations without some extensive discussion of their objectives, some preliminary observations may be briefly stated. The behavior of the Treasury in managing the debt seems to be clearly stock oriented. Fiscal policy decisions cause the size of the debt to change and the Treasury simply takes the accumulated debt as a given stock. Within the limitations of the existing maturity structure of the debt, the Treasury makes decisions regarding the particular type of securities to issue when existing debt matures, or when new debt is incurred. It does not seem possible for the Treasury to behave in such a way as to create flows of debt over time periods. The issue of bills by the Treasury is oriented toward the establishment of a stock of this security relative to desired stock of other types and maturities of securities making up the total Federal debt.

The behavior of the Federal Reserve Open Market Account is not so easy to classify. Monetary policy market transactions take place more frequently than Treasury issues. The goal of these actions is to change the level of member bank reserves (which constitute a stock?). To obtain the required effect, a certain quantity of bills must be bought and sold. It seems that the <u>size</u> of the transaction is clearly more important than the <u>quantity held</u> by the System Account after the transaction. Although the Federal Reserve System may not be attempting to maintain a particular stock of bills in its portfolio, the decisions regarding the quantities to buy or sell in the open market are not necessarily flow goals. The quantity of securities to be traded depends (along with other considerations) upon the desired quantitative effect on member bank reserves. The quantity decided upon will probably not be traded on a single day, but over a period of time. The question is whether open market trading constitutes behavior aimed at the establishment of a stock or the creation of a flow (of securities, reserves, or the money supply?).

The objectives of open market operations and Treasury debt management will be investigated in greater detail in the subsequent sections.

Conflicting Objectives of Treasury Debt Management

The quantity of U. S. Treasury bills in existence is determined by the Treasury's management of the Federal debt. Given the size of the debt, the Treasury can make decisions as to: (1) the maturity of new issues and replacement of maturing issues, and (2) the types of securities to issue (marketable or non-marketable, restricted or non-restricted, bill, Certificate of Indebtedness, note, bond, or special issue). These categories are somewhat overlapping since if a maturity of three months is to be issued, it must be a Treasury bill.

In making these decisions the Treasury may attempt to "optimize" (1) the distribution of holdings of the debt, (2) the stabilization effect on the economy, (3) the length of the average maturity of the debt or the structure of the maturity, and (4) the interest cost to the Treasury. In many cases more than one goal may be attainable, but the Treasury is seldom able to meet all goals simultaneously with any particular debt management operation. Suppose that stabilization effects require lengthening the average maturity of the debt by selling bonds with more than ten years to maturity. If the long-term interest rate were above the short-term rate (which is the normal situation), then the interest cost on this new issue or replacement could not be minimized. The behavior of the Treasury in attempting to meet these goals will be discussed briefly, in the order they are listed above.

(1) The ability of the Treasury to affect the distribution of holdings of the debt lies partially in issuing restricted or non-marketable debt instruments. The use of restricted debt has not been of great importance over the period 1952-1964, and non-marketable debt consists mainly of U. S. Savings Bonds, Investment Bonds, and special issues for trust accounts, international funds, and similar purposes.[186] Since Savings Bonds and special issues are not close substitutes for bills in holders' portfolios, the relevant area of debt management for this study is the marketable portion of the Federal debt. Within the limits of the marketable debt, the principal issue regarding distribution of debt ownership has been bank holding of short-term debt instruments and the resulting "liquidity" effects and "monetization" of the short-term debt with resulting inflationary consequences.[187] These problems became most acute immediately preceding the Treasury-Federal Reserve System Accord, when the debt was made almost perfectly liquid through the rigid support of the rate structure through pegging.[188] These liquidity aspects of debt management are related to the stabilization effects of the debt.

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[186] For the totals of debt in these categories for any year, see the relevant Annual Report of the Secretary of the Treasury on the State of the Finances.

[187] A theoretical discussion of Treasury behavior emphasizing the liquidity aspects of debt management in relation to bank holdings of Federal debt may be found in: Jacob Cohen, "A Theoretical Framework for Treasury Debt Management," The American Economic Review, Vol. XLV, No. 3 (June, 1955), pp. 320-344.

[188] For a discussion, see Gaines, *op. cit.*, pp. 64-65.

(2) Generally, contracyclical debt management requires shortening the average maturity of the marketable debt in periods of recession and lengthening the average maturity in periods of prosperity. Shortening the maturity length in the recession is brought about by financing the fiscal deficits, and refinancing maturing securities, in the form of short-term debt instruments. In periods of prosperity, fiscal surpluses can be used to retire long-term debt, or refinancing can follow a pattern of retiring "shorts" and issuing "longs." Selling short-term securities increases general liquidity, and, in periods of recession, allows the Treasury to borrow without competing in the capital market with potential investment funds. On the other hand, in periods having inflationary pressures, the Treasury is lengthening the average maturity, reducing liquidity and competing for private investment funds.[189] Contracyclical debt management generally would mean increases in the relative quantity of marketable debt in the form of bills in periods of recession, and decreases in the quantity of bills relative to total marketable debt in periods of prosperity.

(3) Clearly the average maturity and the structure of the marketable debt are necessary considerations in the concept of contracyclical

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[189] Rolph, _op. cit._, Musgrave, _op. cit._, and Tobin, _op. cit._, support the proposition, by theoretical arguments, that appropriate debt management policy would attempt to attain the desired effect on the level of aggregate demand at the lowest interest cost. Brownlee and Scott, _op. cit._, argue that any interest cost reduction will be very small and that the stabilization effect alone is a relevant goal. These theoretical arguments take various routes to their common conclusions. A good theoretical discussion of this view is provided in: Thomas A. Beard, "Counter-Cyclical Debt Management-A Suggested Interpretation," _The Southern Economic Journal_, Vol. XXX, No. 3 (January, 1964), pp. 244-252; plus Robert J. Lawrence, "Counter-Cyclical Debt Management: Comment," and Beard's, "Reply," _The Southern Economic Journal_, Vol. XXXI, No. 3 (January, 1965), pp. 251-256.

debt management. Several economists have indicated that some "optimum" structure of the debt should be a more important goal in debt management than any attempts to use the debt for contracyclical purposes.[190] Therefore, the average maturity (or the structure of the debt) is viewed as an independent objective. The arguments advanced in support of a "neutral" or "stable" maturity structure are based on the supposition that financing such a debt, (a) would not create disturbing effects on securities markets with large irregular refundings, (b) would not interfere with monetary policy operations of the Federal Reserve System, and (c) would be routine--eliminating any uncertainty regarding the type and timing of Treasury debt management.

The maturity structure of the debt is also related to the ownership distribution of the debt and the fear of monetization.[191] The traditional view is simply that the desirable debt structure should be long-term.[192] As a result, one of the basic goals of the Treasury has been to lengthen

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[190] Gaines, op. cit., pp. 272-276, feels that a debt management goal of a "neutral" maturity distribution is more desirable than attempts at contracyclical management because the Treasury does not have the ability, at this time, to be very effective in using debt management for stabilization purposes, whereas a "neutral" maturity distribution is an attainable goal. Also, Friedman (A Program for Monetary Stability, op. cit., pp. 52-65) argues the desirability for a "stable" maturity structure (any structure seems all right so long as it is stable) and only two types of debt instruments (very short and quite long).

[191] For arguments that the problem of monetization is unfounded, see Gaines, op. cit., pp. 249-252; Friedman, A Program for Monetary Stability, op. cit., pp. 53-57; and Beard, "Debt Management: Its Relationship to Monetary Policy, 1951-1962," op. cit., p. 67.

[192] Richard A. Musgrave, "Credit Controls, Interest Rates, and Management of Public Debt," Income, Employment, and Public Policy: Essays in Honor of Alvin Hansen (New York: W. W. Norton and Co., Inc., 1948), pp. 241-246.

the average maturity of the debt whenever possible.[193] Unfortunately, as far as success is concerned, Treasury attempts to lengthen the debt maturity have been frustrated by the other basic objectives, especially interest minimization.

(4) The total interest cost per year on the U. S. Government debt is an item which must be appropriated each year by Congress in the administrative budget. With the large debt, and higher interest rates than in the immediate postwar period, this cost has increased to around $10 billion per year. It is understandable, therefore, that the Treasury is concerned with keeping this annual cost as low as possible.[194] Generally, interest minimization requires selling short-term securities in periods of prosperity (when rates are high--allowing these securities to mature relatively soon) and selling long-term securities in periods of recession (when rates are low--allowing these securities to yield low rates after the general level of rates increase). This is, of course, exactly the opposite of contracyclical debt management policy just discussed.[195]

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[193] This view is apparent in "The Government's Management of Its Monetary, Fiscal, and Debt Operations," Part 6C--Answers to Questions of Monetary Policy and Debt Management, Employment, Growth, and Price Levels, Hearings before the Joint Economic Committee of the Congress of the United States, 1959, especially pp. 1721-1728.

[194] For an example, see the testimony by Secretary of the Treasury Snyder, Monetary Policy and the Management of the Public Debt, Hearings before the Subcommittee on General Credit Control and Debt Management of the Joint Economic Committee on the Economic Report, 82nd Congress, 2nd Session, March, 1952, pp. 7-70.

[195] This policy has been classified as "pro-cyclical" by William E. Laird, "The Changing Views on Debt Management," The Quarterly Review of Economics and Business, Vol. 3, No. 3 (Autumn, 1963), pp. 7-17. For a criticism of this policy, see John M. Culberson, "A Positive Debt Management Proposal," The Review of Economics and Statistics, Vol. XLI, No. 2 (August, 1959), pp. 89-98. For a defense, see Herbert Stein, "Managing the Federal Debt," Journal of Law and Economics, Vol. 1 (October, 1958), pp. 97-104; and Smith, op. cit., Smith shares this action for interest minimization with the goal of an "optimum" structure.

The goal of interest minimization is probably more subject to analysis with simple theoretical economic tools than any one of the other three goals.[196] Given the demand schedules for various types of instruments, for interest minimization the Treasury should issue various quantities of securities to equate the marginal interest outlays for these securities. For any particular new issue or reissue, there is a least cost combination of securities. Interest minimization does not necessarily imply issuing or reissuing a required quantity of debt in the security which is currently yielding the lowest rate of interest, or in attempting to equate the average yield of all types of securities. Equating marginal yields is compatible with any shape yield to maturity pattern--depending on the demand schedule of the various securities. The problem which complicates this type of simple analysis is the fact that debt instruments, once issued, normally exist until they mature, and the minimization of interest of a particular sale may not be minimization over the life of the issued securities. For instance, if a quantity of ten year bonds are sold at four per cent and three months later the market rate had fallen to three per cent, it is evident that the interest cost would not be minimized over the period. However, if a year later the yield were to have risen to five per cent (and remained at that level over the remainder of the life of these securities) interest minimization might have been approached over the complete period.

True interest minimization would require the Treasury not only to know the position, elasticities, and cross elasticities of all the demand

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[196] Jacob Cohen, "On the Theory and Measurement of Treasury Interest Saving," The Southern Economic Journal, Vol. XVII, No. 3 (January, 1951), pp. 257-269.

schedules at the time of an issue, but that it also be able to predict all changes in these relationships to infinity.[197] Actually, the perspective of debt management is a relatively short period. Moreover, the conflicting objectives of debt management are continually being evaluated in response to rapidly changing economic conditions. Finally, as Musgrave has pointed out, debt management is made even more complex by the fact that "debt policy deals with _stocks_, whereas fiscal policy deals with _flows_."[198] It is obvious that there is no such thing as an "optimum" debt management policy, especially under conditions of continuing economic change.

The preceding discussion has emphasized the conflicts between alternative goals of debt management, primarily as seen by the economic theorist. Now, however, it would be instructive to review: (1) the stated policy objectives of Treasury debt management, and (2) the success in achieving these objectives. In the brief period covered by this study, the objectives of the Secretary of the Treasury in managing the debt have undergone some gradual reordering and some rather sudden shifts.[199]

A Review of Policy Statements

This review of stated debt policy begins with John W. Snyder (Truman--June, 1946-January, 1953) who was Secretary of the Treasury in the period of pegging of rates on Federal securities and through the Treasury-Federal Reserve System Accord (March, 1951). After the Accord,

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[197] Musgrave, _The Theory of Public Finance_, _op_. _cit_., p. 590.

[198] _Ibid_., Underlining added.

[199] For a detailed review of debt management in the period, see Gaines, _op_. _cit_., and Smith, _op_. _cit_.

the principal goals were strongly influenced by the fear that the interest rates on Government securities would increase in a free market situation. The debt management objectives under Snyder, after the Accord, were listed as:

> ...maintenance of the confidence in the credit of the Government; (2) maintenance of a sound market for the securities of the United States Government; (3) restraint during much of the period, of overall credit expansion; (4) increase in the ownership of Government securities by nonbank investors and reduction in the holdings of the banking system; (5) adjustment from time to time in the wartime pattern of interest rates, as this becomes appropriate.[200]

The period between the Accord and the change of administration was relatively short. Snyder was followed by George M. Humphrey (Eisenhower--January, 1953-July, 1957). The goals of debt management policy under this administration were stated as:

> The specific objectives are to reduce the volume and maturities of bank financing to manageable size and form and to get more of the debt into the hands of long-term investors. These objectives will in themselves aid economic stability, and will at the same time provide greater freedom of action for the Federal Reserve System to perform its necessary public functions in the monetary and credit field without interference from the Treasury.[201]

Humphrey was succeeded by Robert B. Anderson (Eisenhower--July, 1957-January, 1961), who, for all practical purposes, continued the debt management policies then underway.

> As in other years, the Treasury's major debt management objectives were to contribute to the growth and stability of the economy and to improve the structure of the debt. Within the limits prescribed by these two overriding objectives the Treasury sought to borrow as cheaply as possible.

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[200] Annual Report of the Secretary of the Treasury on the State of the Finances for 1952, p. 12.

[201] Annual Report of the Secretary of the Treasury on the State of the Finances for 1953, p. 4. Note that Humphrey excludes interest minimization as a goal.

> Progress toward these debt management objectives requires that the Treasury seek funds as largely as possible from nonbank investors, rather than from commercial banks, in order to reduce the inflationary potential of Treasury financing during a period of high economic activity. Within the nonbank investor grouping the preference is to borrow from true long-term savers rather than from short term investors.[202]

It should be pointed out that debt management contributing "to the growth and stability of the economy" evidently does not mean managing the debt contracyclically because Anderson publicly argued that such a policy "has some serious shortcomings."[203]

Douglas Dillon (Kennedy-Johnson--January, 1960 until the end of this period of analysis) succeeded Anderson as Secretary of the Treasury and the debt management goals were largely unchanged. Dillon listed Treasury debt management goals as:

> Despite continuous shifts in the economic environment both at home and around the globe, debt management decisions must be made in the light of certain fundamental and sometimes conflicting objectives.
>
> First, to raise the money required to meet the Government's obligations.
>
> Second, to borrow as cheaply as possible, consistent with meeting other debt management objectives.
>
> Third, to make sure that the Government carries out its borrowing in a way that fosters, rather than inhibits, economic stability and sustained growth of the economy.
>
> Fourth, to conduct debt operations in such a way as to try to avoid significant international interest rate differentials, which can lead to large and disruptive flows of short-term funds.
>
> Fifth, to work toward a balanced debt maturity structure, in order to facilitate the orderly managing of the debt in

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[202] Annual Report of the Secretary of the Treasury on the State of the Finances for 1960, p. 27. See, however, footnote 205.

[203] Honorable Robert B. Anderson, "Financial Policies for Sustainable Growth," The Journal of Finance, Vol. XV, No. 2 (May, 1960), pp. 127-139. Also see the Treasury answers in: The Federal Reserve and the Treasury: Answers to Questions from the Commission on Money and Credit (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1963).

> future years. This requires maintenance of both a reasonable volume of long-term securities and a sufficient supply of short-term securities to meet the needs of the economy.[204]

The essential difference between these goals and those of Humphrey and Anderson is the fourth point--using debt management to influence the structure of interest rates. Before the Accord, Snyder had relied on the Federal Reserve System to maintain the desired rate structure through open market operations in the Government securities market.

The attempt to influence the rate structure by putting upward pressure on the short-term interest rate for Government securities is an important innovation in debt management. This objective has been referred to as "Operation Nudge" or "Operation Twist." This operation is particularly relevant to the study of the bill rate movement since the procedure followed by the Treasury for putting upward pressure on the rate for bills has been through increasing the quantity of bills outstanding.

This new objective for debt management illustrates the need for the Treasury to change the relative importance of various goals. In the period since the Accord, those charged with managing the debt seem to have become a bit more aware that the desired objectives are conflicting, and changing economic conditions will bring about changes in emphasis or direction in attempting to properly manage the debt.

This recognition suggests an additional goal of Treasury debt management that has not been stated explicitly, although it seems implicit in Dillon's fifth point, namely the objective of "flexibility." Flexibility means simply the ability to change from the pursuit of one objective to

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[204] _Annual Report of the Secretary of the Treasury on the State of the Finances for 1961_, pp. 13-14.

some other if changing economic conditions dictate the need. Since the Treasury does not make a practice of retiring issues by buying their own outstanding debt,[205] flexibility requires that some portion of the debt be near maturity--the larger the portion, the greater the flexibility. Treasury bills and short-term debt play an important role in providing this flexibility. On maturity, bills may be reissued or securities of longer term to maturity may be issued in replacement. If there were no debt near maturity, and if fiscal policy were not changing the size of the debt, there would be nothing to manage.

The concepts and objectives of "appropriate" debt management by the Treasury have been discussed. Now it is necessary to examine which goals were pursued and the resulting effect of these operations on the structure and maturity of the marketable debt, especially the short-term and bill portion.

Debt Management and the Quantity of Bills Outstanding

Generally, the Secretaries of the Treasury have not been very successful in attaining their stated goals. A recent evaluation of Treasury debt management by John M. Culbertson is quite typical of economists' views.

> Debt management policy is in an unhappy state: The Treasury's bunching of sales of longer-term issues during recession is patently procyclical in effect. The term to maturity of the government debt moves shorter--except when recession invites the Treasury to dump bonds on the market. Cash borrowing

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[205] Advance refunding, a practice initiated in 1959 under Anderson, comes near to purchasing outstanding debt in the operational sense, since long-term or intermediate length securities are reissued before the existing security actually matures. Also see the Appendix of The Federal Reserve and the Treasury: Answers..., op. cit.

> needs seemingly cannot be met in any way except by issuing liquidity instruments. A mountain of bonds approaches maturity and apparently will be replaced by short-term securities. The debt management policy which economists had hoped to make an important force for economic stabilization stands forth as worse than impotent; it is procyclical with an inflationary bias.[206]

Many of the criticisms of debt management policy have not been directed at the Treasury for pursing the wrong goals, but in pursuing no goals at all. The first point of Dillon's debt management policy was "to raise the money required to meet the Government's obligations." Although this goal was not stated explicitly by the other Secretaries, it is obviously an overriding objective and must be attained regardless of the other goals. In attempting to meet this objective, the Treasury has done a great deal of "tailoring," or selling those securities for which various sectors of the economy have illustrated rather strong demand. This policy of expediency has resulted in a great variety of types and maturities of Federal debt instruments and generally a shortening of the maturity structure of the marketable debt. It also indicates that the Treasury has been reluctant to make any serious attempts at contracyclical debt management.

Very generally, over the period 1952-1963, the total marketable Federal debt has increased 45.4 per cent, from $142.7 billion in January, 1952 to $207.5 billion in December, 1963.[207] In the same period, the

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[206] Culbertson, "A Positive Debt Management Proposal," op. cit., p. 89. For other critical views of the general success, see: Gaines, op. cit.; Friedman, A Program for Monetary Stability, op. cit.; Smith, op. cit.; and Burton C. Hallowell and Kossuth M. Williamson, "Federal Debt Management, 1953-1958," The Review of Economics and Statistics, Vol. XLV, No. 1 (February, 1963), pp. 47-54.

[207] Total marketable debt in 1952 was down from the postwar high of $189.6 billion of December, 1946. The quantities of debt in each of these classifications, and the percentage calculations are based on end-of-month values.

quantity of U. S. Treasury bills increased by 184.5 per cent from $18.1 billion to $51.5 billion; and the portion of marketable debt maturing within one year increased by 92.7 per cent from $46.4 billion to $89.4 billion. Very simply, the quantity of marketable debt within one year of maturity increased relative to the total marketable debt, and the quantity of Treasury bills increased relative to the portion of debt within one year to maturity. The quantities of debt classified as: total marketable, Treasury bills, and debt maturing within one year are shown as of June 30 each year in Table 17.

Until 1959 the increase in the quantity of Treasury bills was closely related to the general increase in the total marketable debt. The quantity of debt within one year to maturity increased slightly relative to the total marketable debt, but showed a great deal more volatility than either of the other two classifications. This may be seen more clearly in Table 18, with the quantities of bills and the quantities of marketable debt maturing within one year expressed as a percentage of total marketable debt.

From 1959 the quantity of bills as a percentage of the total marketable debt became larger as six-month, nine-month, one-year, and tax anticipation bills were initiated to replace Certificated of Indebtedness.[208] In late 1959, Treasury bills moved to more than 50 per cent of

[208]At the end of February, 1959, approximately $38 billion of Certificates of Indebtedness were outstanding. This quantity declined to $5.5 billion by the end of August, 1961, and has moved rather erraticly between $10 billion and $20 billion until the end of 1963. There have been no Certificates outstanding over the period May, 1964 to the present--November, 1965.

TABLE 17.--U. S. Government total marketable debt, Treasury bills, and marketable debt maturing within one year, June 30, 1952-1964[a]
(in millions of dollars)

Year	Total Marketable	Treasury Bills	Maturing Within One Year
1952	140,407	17,219	46,367
1953	147,335	19,707	65,270
1954	150,354	19,515	62,734
1955	155,206	19,514	49,703
1956	154,953	20,808	58,714
1957	155,705	23,420	71,952
1958	166,675	22,406	67,782
1959	178,027	32,017	72,958
1960	183,845	33,415	70,467
1961	187,148	36,723	81,120
1962	196,072	42,036	88,442
1963	203,508	47,230	85,294
1964	206,489	50,740	81,424

[a]Issues are classified to final maturity except partially tax-exempt bonds, which are classified to earliest call date.

Sources: Total marketable debt and marketable debt due within one year are from Table 31, Annual Report of the Secretary of the Treasury on the State of the Finances for 1963, p. 504, and the 1964 data from the Treasury Bulletin. Treasury bill data are from various monthly issues of the Treasury Bulletin.

TABLE 18.--U. S. Treasury bills as a percentage of total Federal marketable debt, and as a percentage of marketable debt due within one year, June 30, 1952-1964[a]

Year	Treasury Bills as a Percentage of:[b] Total Marketable Debt	Marketable Debt Due Within One Year
1952	12.3	37.6
1953	13.4	30.2
1954	13.0	31.1
1955	12.3	36.9
1956	13.4	35.4
1957	15.0	32.6
1958	13.4	33.1
1959	18.0	43.9
1960	18.2	47.4
1961	19.6	45.3
1962	21.4	47.5
1963	23.2	55.4
1964	24.6	62.3

[a]Total marketable debt and marketable debt within one year to maturity are classified to final maturity except partially tax-exempt bonds, which are classified to earliest call date.

[b]Percentages are rounded to nearest one-tenth of one percent.

Sources: Calculated--total marketable debt and marketable debt within one year data were taken from Annual Report of the Secreatry of the Treasury on the State of the Finances, 1963, Table 31, p. 504; bill data are from various issues of the Treasury Bulletin.

the marketable debt within one year of maturity and fluctuated around this percentage until early 1963 when bills moved to almost 60 per cent of within-one-year marketable debt. This increase in bills, along with the general increase in the short-term category, was occasioned by the attempt by the Treasury to raise short-term rates relative to international short-term rates and domestic longer-term rates.

The increase in the quantity of bills and in the quantity of marketable debt within one year to maturity relative to the total marketable debt contributed to a general decline in the average length of maturity. This shortening occurred even though lengthening was a stated objective of the Treasury throughout the period. Since the majority of bills are in the three-month category, an increase in bills as a percentage of the total marketable debt would require relatively large increases in quantities of longer-term debt if the average maturity were to remain constant or lengthen.

The maturity distribution of the marketable debt as a percentage of the total marketable debt at yearly intervals is shown in Table 19. From these data it is apparent that the erratic downward movement of the 5 to 10 year category up to June 30, 1958, coupled with the large attrition in the 10 to 20 year category since 1958, has contributed to the decrease in the average maturity length. Increases in the average maturity have been brought about in the most recent months by some important increases in the portion of the marketable debt having more than 20 years before maturity.

The average time to maturity of the marketable debt as of the yearly June 30 dates is illustrated in Table 20. The average maturity of

TABLE 19.--Maturity distribution of U. S. Government marketable debt by maturity classes as a percentage of total marketable debt, as of June 30, 1952-1964[a]

Year	Maturing Classes of Debt In Years				
	Less than One Year	1-5	5-10	10-20[b]	Over 20
1952	33.0	34.1	9.9	18.3	4.7
1953	44.3	24.5	10.6	19.5	1.1
1954	41.7	19.9	18.3	19.0	1.1
1955	32.0	25.2	22.1	18.4	2.3
1956	37.9	22.2	18.7	18.4	2.8
1957	46.2	26.1	7.9	17.0	2.8
1958	40.7	25.5	12.9	16.6	4.3
1959	41.0	32.8	9.6	12.1	4.5
1960	38.3	39.6	11.0	6.9	4.2
1961	43.3	31.2	14.1	5.5	5.9
1962	45.1	29.1	13.3	4.8	7.8
1963	41.9	28.5	18.4	4.1	7.1
1964	39.4	31.7	16.9	4.0	7.9

[a]Due to rounding of the raw data and rounding of the calculations, details may not sum to 100 percent.

[b]Two classifications of debt, 10 to 15 years to maturity and 15 to 20 years to maturity, were summed to obtain the category 10 to 20 years to maturity.

Sources: Total marketable debt and marketable debt due within one year are from Table 31, Annual Report of the Secretary of the Treasury on the State of the Finances for 1963, p. 504, and the 1964 data from the Treasury Bulletin. Treasury bill data are from various monthly issues of the Treasury Bulletin.

TABLE 20.--Average length to maturity of the marketable Federal debt, and changes in the average length to maturity from the preceding year, in months, as of June 30, 1952-1964[a]

Year	Average Length to Maturity	Change from Preceding Year
1952	68.4	-10.4
1953	63.8	- 4.6
1954	66.0	+ 2.2
1955	69.6	+ 3.6
1956	64.5	- 5.1
1957	57.3	- 7.2
1958	62.9	+ 5.6
1959	55.3	- 7.6
1960	52.3	- 3.0
1961	53.6	+ 1.3
1962	58.5	+ 4.9
1963	60.9	+ 2.4
1964	60.5	- 0.4

[a]Issues are classified to final maturity except partially tax-exempt bonds, which are classified to earliest call date.

Source: Mimeographed by Office of the Secretary of the Treasury, Office of Debt Analysis, July, 1965.

the marketable Federal debt declined from 72.1 months in January, 1952, to 50.4 months (the post-war low) in January, 1960 and again in September, 1960; then lengthened to 60.6 months by December, 1963. From Table 20, it appears that debt lengthening occurred in periods of recession. From viewing the average length of maturity on a monthly basis relative to reference cycle peaks and troughs, the average length increased in each "peak to trough" time period. The change in the length of the average maturity in the reference cycle periods are shown in Table 21. The average length to maturity lengthened in each cyclical movement from peak to trough and shortened in two of three movements from troughs. This indicates that debt management in these periods was procyclical instead of contracyclical.[209]

It is interesting that the only instance of lengthening the average maturity of the marketable debt in a period of expansion occurred in the period February, 1961 through December, 1963, while the Treasury was simultaneously increasing the quantities of Treasury bills and short-term securities. This lengthening was possible largely through the expansion in the 5 to 10 year and over 20 year time to maturities. It should be pointed out, however, that this economic recovery was rather weak and characterized by considerable slack.

The average maturity of the marketable debt outstanding from the Treasury is shown in Chart 11 for the period January, 1953 through September, 1964. The cyclical changes in the average maturity do not occur smoothly, but the general pattern of shortening between troughs is apparent.

A change in the quantities of bills or other short-term securities relative to the total marketable debt directly affects the average time to

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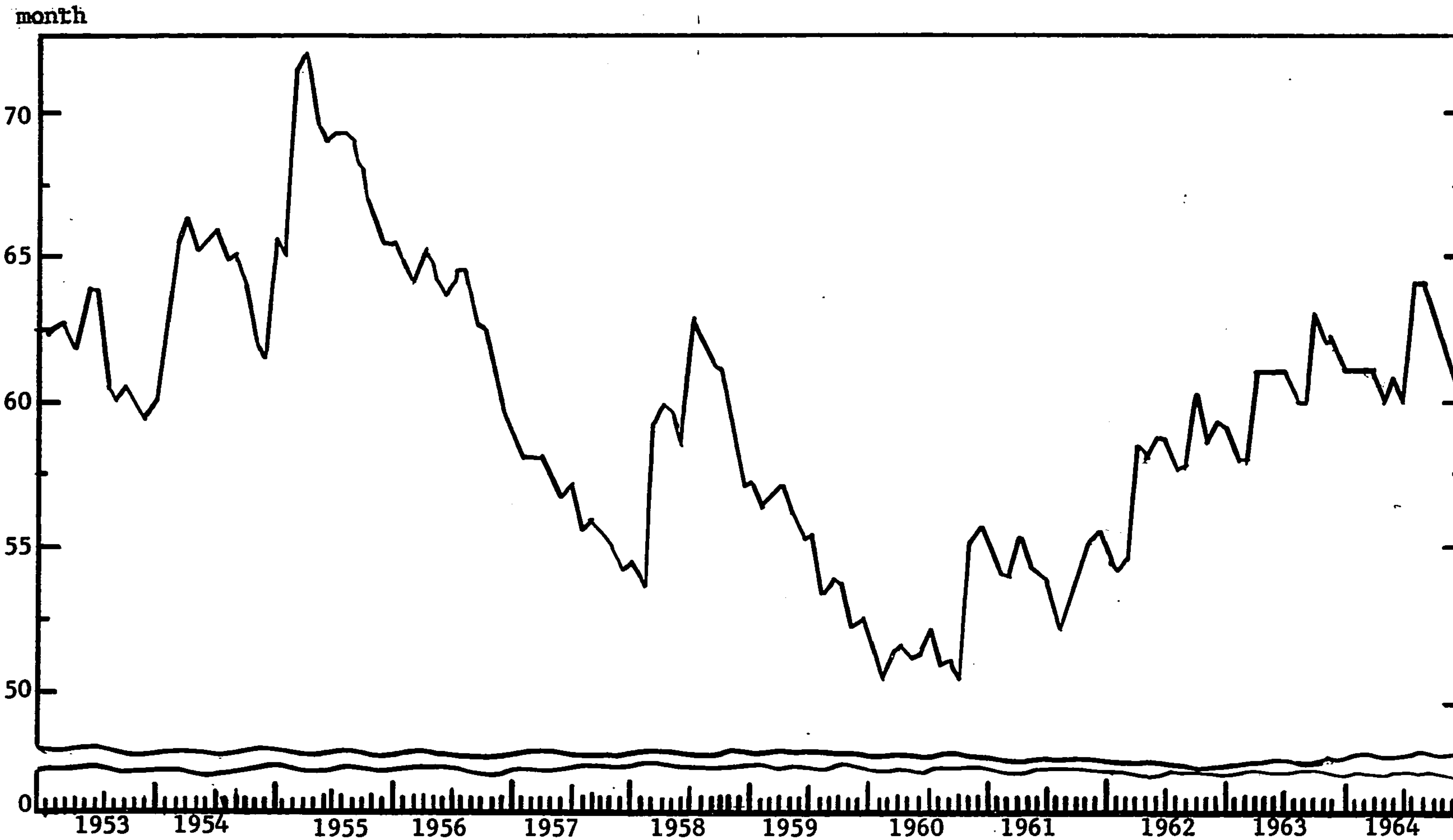
[209]For a more detailed argument regarding the procyclical character of debt management in the period 1953-1958, see Hallowell and Williamson, *op. cit*. Also, see John M. Culbertson, *Full Employment or Stagnation* (New York: McGraw-Hill Book Co., Inc., 1964), pp. 95-100.

TABLE 21.--Movements of the average maturity of the marketable Federal debt, and changes in the average length, as measured from National Bureau reference cycle peaks and troughs, 1952-1964. (Maturities and changes in length are measured in months)

Date	Average maturity	Change from preceding period
A. Movements in Average Maturity from Peak to Trough		
July, 1953 (peak)	60.6	
August, 1954 (trough)	65.0	+4.9
July, 1957 (peak)	55.5	
April, 1958 (trough)	59.4	+3.9
May, 1960 (peak)	51.3	
February, 1961 (trough)	53.7	+2.4
B. Movements in Average Maturity from Trough to Peak		
August, 1954 (trough)	65.0	
July, 1957 (peak)	55.5	-8.5
April, 1958 (trough)	59.4	
May, 1960 (peak)	51.3	-8.1
February, 1961 (trough)	53.7	
through December, 1964	60.3	+6.6

Source: For reference cycle peaks and troughs, Appendix A, Business Cycle Developments, U. S. Department of Commerce (March, 1964), p. 61; for average maturities, see Source of Table 20, and note 1.



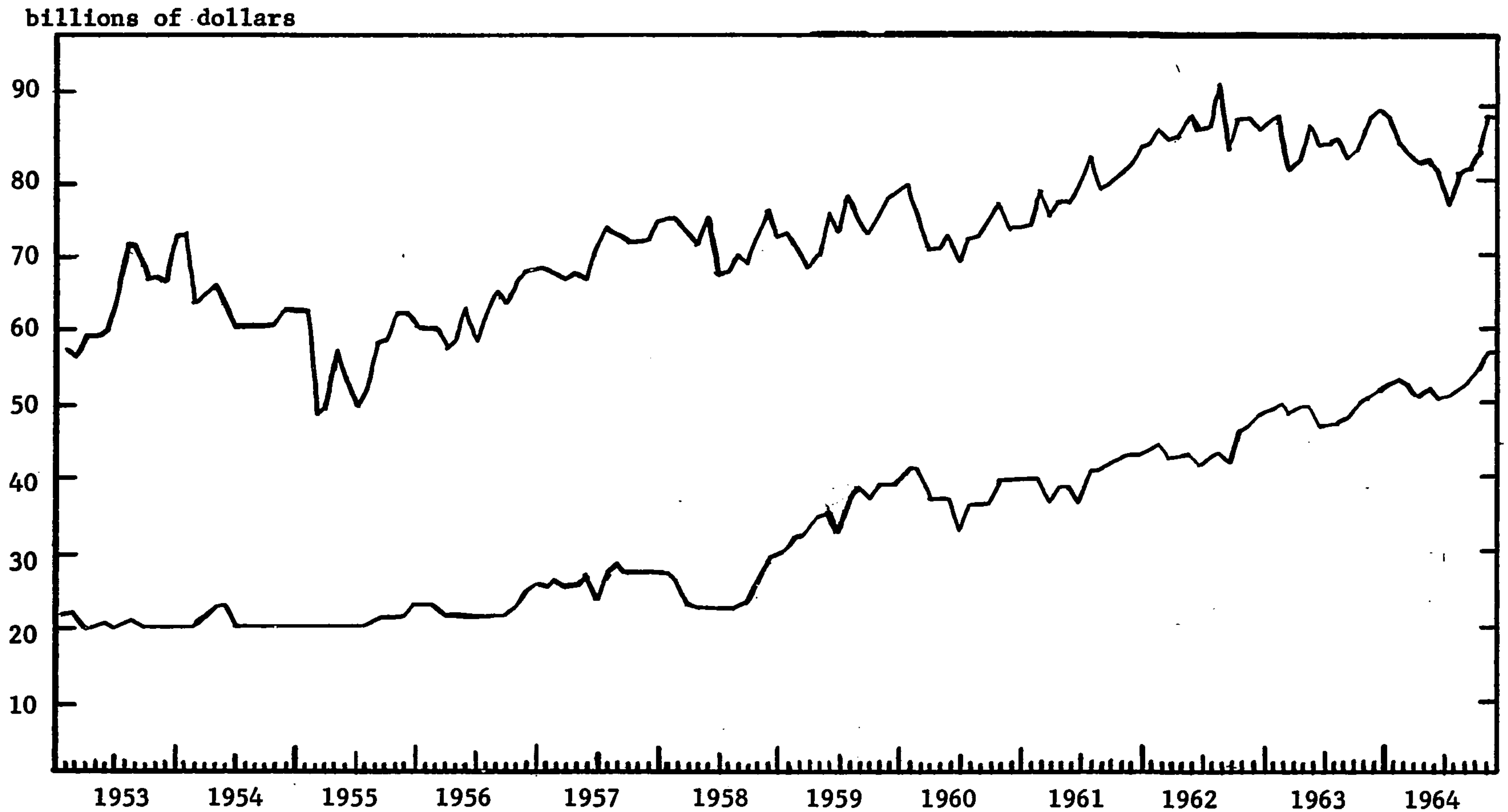
Source: Unpublished release from the Office of Debt Analysis, and the Treasury Bulletin, various monthly issues 1963-1964.

Chart 11.--Average time to maturity of the U. S. Government marketable debt in months, 1953-1964.

maturity. However, it does not appear that the cyclical variations in the average time to maturity have been caused solely by increases and decreases in the quantity of securities within one year to maturity. The quantity of total marketable debt maturing within one year and the quantity of Treasury bills outstanding are illustrated in Chart 12.

Only some very general statements may be made regarding the direct effects of short-term financing on the average time to maturity. It appears that the increase in the quantity of within one year marketable debt in the 1955-1957 period is associated with the corresponding decrease in the average time to maturity. Also, in the late 1958 through 1959 period, the large increase in the quantity of bills appears closely related to the decline in the average maturity. Other related movements between the average time to maturity and these two classifications of short-term debt are obscured by changes in the quantities of other longer-term securities and the passage of time. Generally, however, the cyclical movements in the average time to maturity are not directly associated with changes in the quantities of short-term debt since any cyclical movements in these quantities are not pronounced, and are much too irregular for any general conclusions.

The quantity of debt within one year to maturity has shown a general increase over the period 1953-1964, but has moved rather erratically within rather narrow limits. The quantity of bills has also shown an increase over the period, but since 1958 the increase in bill quantities has been larger than the increase in the total quantity of marketable debt within one year to maturity. The difference between total debt within one year to maturity and Treasury bills has decreased since 1958. This



Source: Calculated from information in various monthly issues of the Federal Reserve Bulletin.

Chart 12.--Total marketable Federal debt within one year to maturity, and the total quantity of Treasury bills outstanding, monthly, 1953-1964.

difference (marketable debt within one year--excluding Treasury bills) decreased from $45.4 billion in June, 1958 to $30.7 billion in June, 1964; or from 67.0 per cent to 37.7 per cent of total marketable debt within one year to maturity. The pattern of change may be ascertained from Table 18 and Chart 11. Increases in the quantity of bills should exert upward pressure on the bill rate, and in addition, decreases in the quantities or bill substitutes should tend to cause the bill rate to rise--assuming demand preferences are constant.

However, the quantities of securities issued by the Treasury are not necessarily the quantities available to the public to hold because of the holdings of Government agencies and trust funds and the Federal Reserve System. For short-term marketable securities, holdings by agencies and trust funds are not as important as Federal Reserve System holdings. Therefore, the holdings of agencies and trust funds will be reviewed very briefly, while the holdings of the Federal Reserve System will be examined in greater detail.

Government agency and trust fund holdings of bills and other within one year to maturity holdings have shown some volatility over the period 1952-1963, with a general increase in the quantity held. Agency and trust fund holdings of total marketable debt, within-one-year-to-maturity marketable debt, and Treasury bills are shown in Table 22 for June 30 dates. Government agencies and trust funds also hold large quantities of special issues from the Treasury and a smaller quantity of U. S. Government convertible bonds. Total holdings of marketable debt by this sector have increased steadily over the period; and although there has been considerable fluctuation in the shorter maturities, the slight increase is apparent.

TABLE 22.--Government agency and trust fund holdings of United States Government marketable debt as: total, within one year to maturity, and Treasury bills, as of June 30, 1952-1964. (in millions of dollars)

Year	Total	Maturing in less than one year	Bills
1952	3,030	101	41
1953	3,460	163	106
1954	3,546	107	106
1955	3,723	74	40
1956	4,891	927	273
1957	5,491	1,138	130
1958	6,644	899	173
1959	7,001	930	86
1960	7,776	1,070	371
1961	8,503	1,671	801
1962	8,991	1,687	799
1963	11,120	1,849	1,142
1964	12,119	1,822	1,459

Source: Various issues of the Federal Reserve Bulletin.

Changes in bill holdings by Government agencies and trust funds affect the stock of bills available to the public, and therefore the bill rate. Assuming a high cross elasticity with respect to interest between bills and other Federal securities within one year to maturity, changes in short-term holdings of securities other than bills also should affect the bill rate. However, as is evident from Table 22, Treasury open market operations are small relative to the total quantity of bills outstanding and total Federal debt due within one year, therefore the resulting effect on the bill rate should not be great.

On the other hand, Federal Reserve System holdings of short-term debt are large relative to total Treasury issues; and furthermore, Treasury bill holdings have fluctuated widely due to the open market activities of the System.

Federal Reserve System Open Market Operations and the Quantity of Bills

The Federal Reserve System maintains a portfolio of U. S. Government securities. Through the Federal Reserve System Open Market Account, the System executes open market purchases and sales of Government securities in order to adjust member bank reserves to desired levels. *Ceteris paribus*, open market purchases increase member bank reserves, and open market sales reduce the level of reserves, with the money supply changing in the same direction as member bank reserves.

In addition to affecting the reserve position of member banks and the supply of money, open market transactions affect the quantity and the maturity distribution of U. S. Government securities available for the public to hold.[210] In this sense, open market operations are also debt management operations. In the period between March, 1953 and February, 1961, the System followed the policy of "bills only" in its open market operations, and even since 1961, the bulk of trading has been in bills. Open market operations really have a dual effect on the Treasury bill rate, (1) an immediate change in the rate due to the change in the stock

[210]Warren L. Smith, "The Instruments of General Monetary Control," *The National Banking Review*, Vol. 1, No. 1 (September, 1963), p. 48. For an analysis of the relevance of member bank reserves as the goal of monetary policy, see: Meigs, *op. cit.*

of bills available to the public, and (2) a lagged effect on the bill rate due to the change in demand for bills by commercial banks and other holders resulting from the change in the money supply. These effects are illustrated in Chart 13 for an open market purchase. In the initial time period, the stock of bills is S_o, with the total demand schedule D_o, and the equilibrium bill rate at i_o. The open market purchases of S_oS_1 reduces the stock of bills available for the public to hold, with the equilibrium bill rate falling from i_o to i_1 due to the stock changes.[211] Then, due to the change in the level of member bank reserves--given reserve requirements, the level of "free reserves," and the total change in the money supply due to the multiple expansion of this transaction after "n" periods--the demand to hold Treasury bills should increase. The increase in the total demand schedule from D_o to D_n, due to the increase in reserves and the money supply, causes the equilibrium rate to decline to i_n. An open market sale would increase the stock immediately and, with a lagged effect, decrease the total demand causing the bill rate to increase. In either case, the more elastic is the demand schedule, the less change in the bill rate from a given change in the bill stock. The degree of the change in demand arising from an open market operation is probably more influential in causing the rate change than the change in the stock.

The change in the stock of bills due to open market operations in any monthly period is known, but the change in demand, and the length of

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[211] James Tobin, "Commercial Banks as Creators of Money," Banking and Monetary Studies, Ed. Deane Carson (Homewood, Ill.: Richard D. Irwin, Inc., 1963), p. 417: "The open-market operations which bring about the increased supply of reserves tend to lower interest rates. So do the operations of the commercial banks in trying to invest their new reserves."

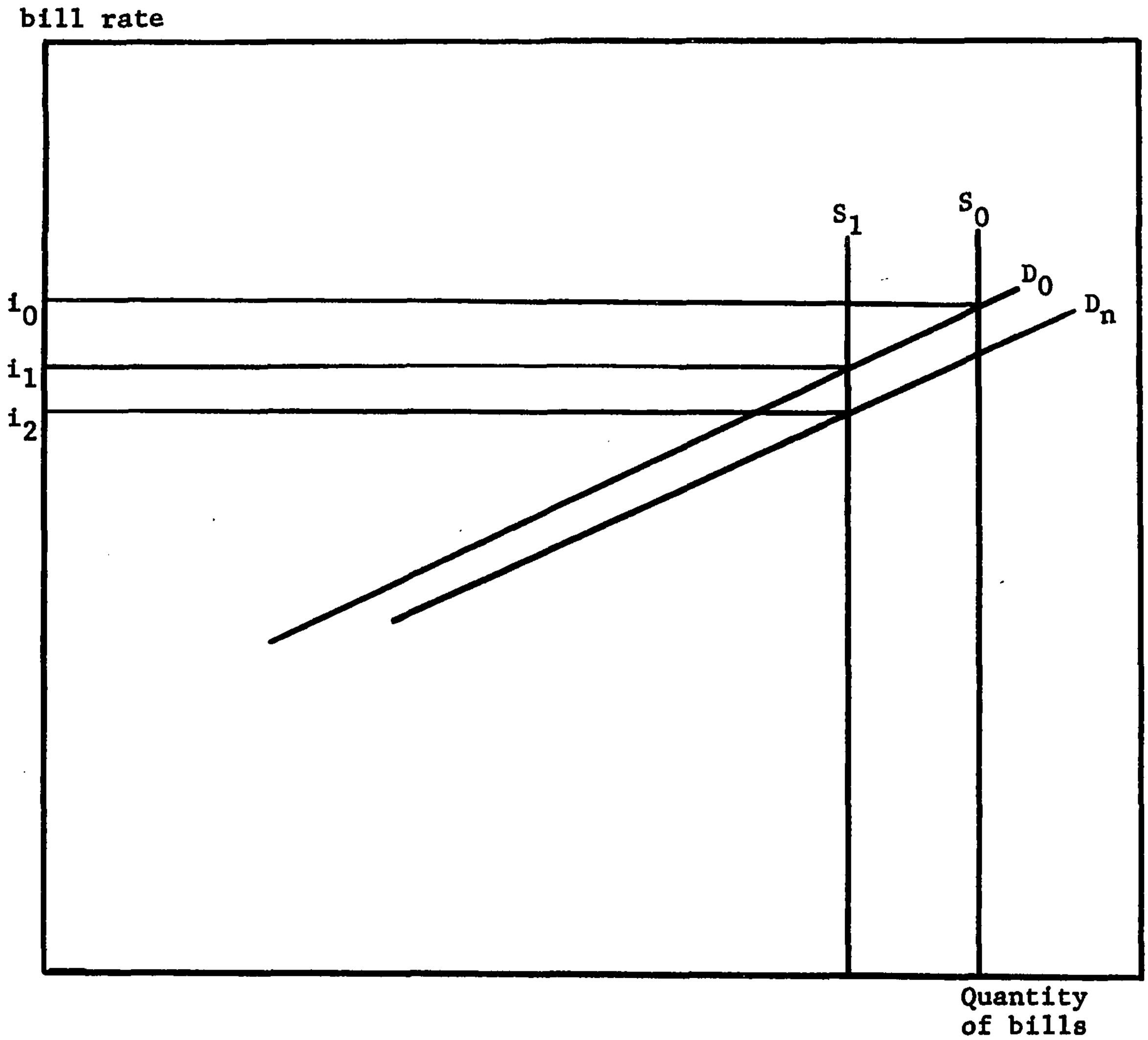

Chart 13.--Effect of an open market purchase by the Federal Open Market Committee on the Treasury bill rate.

time required for the initial change in the money supply to "work itself out" through the commercial banking system introduce significant problems in attempting to measure empirically either the singular or the combined effect on the bill rate. It was argued in Chapter V that changes in demand or supply conditions produce instantaneous changes in the bill rate. In this case, however, the bill rate is probably influenced by lagged changes in demand, the length of the lag depending on commercial bank reaction to changes in their reserve position. Given a Federal Reserve System purchase of bills, the level of free reserves will be immediately increased. The effect on the demand for bills then depends on the reaction of the member commercial banks to the increase in reserves. Member banks may decide to hold the additional reserves idle, pay off indebtedness to the Federal Reserve System, buy bills, buy longer term Government securities, or make private loans or investments. The distance of the shift in the demand to hold Treasury bills depends, therefore, on the increased demand to hold bills by commercial banks, <u>and</u> the increased demand for bills by other institutional sectors which depends partially on the portion of the additional reserves that commercial banks desire to hold idle. Given an increase in the money supply the demand for all interest bearing assets shifts to the right, but it is obvious that the relative change in the demand for different assets depends on a multitude of variables, for instance the phase of the business cycle. The ratio of Government security holdings of commercial banks to their adjusted demand deposits tends to increase in recessions and to decrease near the peak of a cycle. Other sectors, of course, behave differently in their asset preferences over the cycle; shifting between long-term and short-term Government securities, some shifting between bonds and equities, and some sectors not shifting between assets but holding greater or lesser quantities of preferred assets. The demand effects are discussed in the following Chapter. Here the effect on the bill rate is being viewed from the supply side--or changes in the stock of bills, as the Federal Reserve Open Market Committee buy and sell bills in the open market.

The Federal Reserve System holdings of total marketable Federal debt, marketable debt within one year to maturity, and Treasury bills are provided in Table 23 as of June 30, 1952-1964. Holdings of total marketable debt remains quite constant at between $23 billion and $27 billion until 1962 when it began to increase, reaching nearly $35 billion in 1964. A very large portion of total holdings of marketable debt is within one year of maturity, with the quantity fluctuating between $11 billion and $23 billion, showing considerably more volatility than total holdings. Bill holdings by the Federal Reserve System are not large relative to total holdings, and although volatile, show a slight increase, especially in the last four or five years.

Table 24 shows Federal Reserve System holdings as a percentage of the total marketable debt outstanding for each of the three categories; total, within one year, and bills. The relative constancy of total Federal Reserve System holdings as a percentage of total marketable debt outstanding is evident with the values varying between 14.4 per cent and 16.9 per cent. It is also obvious that the System holds a larger percentage of within one year securities than percentages of total marketable debt or Treasury bills. Since the quantity of bills is included in both of the other categories, it seems that System holdings of marketable debt within one year of maturity, <u>other than bills</u> is very large indeed.

TABLE 23.--Federal Reserve System holdings of United States Government marketable debt as: total, within one year to maturity, and bills, as of June 30, 1952-1964. (in millions of dollars)

Year	Total	Maturing in less than one year	Bills
1952	22,906	11,488	381
1953	24,746	15,505	1,455
1954	25,037	16,280	1,455
1955	23,607	17,405	886
1956	23,758	20,242	885
1957	23,035	20,246	287
1958	25,438	23,010	2,703
1959	26,044	20,687	2,032
1960	26,523	19,385	2,513
1961	27,253	14,677	2,840
1962	29,663	17,197	2,961
1963	32,027	21,490	3,364
1964	34,794	18,029	5,171

Source: Various issues of the Federal Reserve Bulletin.

TABLE 24.--Federal Reserve System holdings of United States Government debt as a percentage of that classification issued by the Treasury: total, within one year, and bills as of June 30, 1952-1964

Year	Percentage that Federal Reserve System holdings are of total Treasury issues classified as:		
	Total	Less than one year	Bills
1952	16.3	24.6	2.2
1953	16.8	23.8	7.4
1954	16.7	26.0	7.5
1955	15.2	35.0	4.5
1956	15.3	34.5	4.3
1957	14.8	28.1	1.2
1958	15.3	33.9	12.1
1959	14.6	28.4	6.3
1960	14.4	27.5	7.5
1961	14.6	18.1	7.7
1962	15.1	19.4	7.0
1963	15.7	25.2	7.1
1964	16.9	22.1	10.2

Source: Tables 17 and 23.

In order to estimate the relative holdings of quantities of within one year debt, Treasury bills have been subtracted from total marketable debt due in less than one year, and from Federal Reserve System holdings of debt due within one year. The results are provided in Table 25. Both the total debt within one year excluding bills and Federal Reserve System holdings show considerable volatility over the period. Federal Reserve System holdings as a percentage of the total also vary, but it is evident that System holdings of other-than-bill marketable debt within a year of maturity are quite large. The Federal Reserve System held over 50 per

TABLE 25.--Marketable Federal securities within one year to maturity, other than Treasury bills, outstanding from the Treasury and held by the Federal Reserve System; and Federal Reserve System holdings of these securities as a percentage of total outstanding, June 30, 1952-1964 (in millions of dollars)

Year	Total Marketable Securities Within One Year of Maturity, Other than Treasury Bills		Percentage of Total Held by the Federal Reserve
	Outstanding[a]	Held by the System	
1952	28,423	11,107	39.1
1953	44,882	14,053	31.3
1954	40,608	14,825	36.5
1955	30,189	16,519	54.7
1956	37,906	19,387	51.1
1957	47,613	19,959	41.9
1958	45,376	21,307	47.0
1959	40,941	18,655	45.6
1960	35,567	16,872	47.4
1961	42,912	11,937	27.6
1962	44,921	14,236	31.7
1963	38,064	18,126	47.6
1964	30,648	12,858	41.9

[a]Since the Federal Reserve Bulletin data has U. S. Government guaranteed marketable debt subtracted out of the totals published in the Treasury Bulletin, the quantities in this category are not directly comparable with the values which could be derived from the data in Table 17.

Source: Various issues of the Federal Reserve Bulletin.

cent of this debt in 1955 and 1956, held over 40 per cent from 1957 through 1960 and again in 1963 and 1964, and has dropped below 30 per cent only once over the entire period. In 1961 when the Federal Reserve System abandoned the "bills only" policy, holdings declined to 28 per cent of the total one year debt (excluding bills) outstanding.

The large System holdings of within one year debt--excluding bills--is important in that the System has held a large portion of bill substitutes continuously over the period 1952-1964, Treasury bills in the hands of the public, therefore, are considerably more important as a percentage of total marketable Federal debt held by the public and marketable debt within one year of maturity in the hands of the public than was indicated in Table 18, where bills outstanding were viewed as a percentage of total and one year debt outstanding.

In Table 26, bills in the hands of the public are compared with total "under one year" marketable debt in the hands of the public. The percentage of bills in the hands of the public has been below 50 per cent on only four out of the 12 June 30 dates over the period, and is in the vicinity of 70 per cent in 1963 and 1964. When the percentages in Table 26 are compared with the corresponding percentages in Table 18, it is found that the differences range between seven and 21 points higher for the "in hands of the public" percentages. The higher relative importance of bills to marketable debt within one year to maturity when viewed as quantities in the hands of the public is due to the fact that the Federal Reserve System holds such a large portion of non-bill short-term debt.

Not only are Federal Reserve System holdings of non-bill short-term debt quantitatively important, System bill holdings occasionally surpass

TABLE 26.--Marketable debt within one year to maturity and Treasury bills in the hands of the public, June 30, 1953-1964. (in millions of dollars)

Year	Marketable debt in the hands of the public		Bills a percentage of total less than one year
	Total less than one year[a]	bills[b]	
1953	48,921	18,146	37.1
1954	45,273	17,954	39.7
1955	32,224	18,588	57.7
1956	37,545	19,680	52.4
1957	49,619	23,003	46.4
1958	43,873	19,530	44.5
1959	51,341	29,899	58.2
1960	49,452	30,531	61.7
1961	63,287	33,082	52.3
1962	68,073	38,276	56.2
1963	61,955	42,724	69.0
1964	61,573	44,110	71.6

[a]From the total marketable debt within one year to maturity outstanding from the Treasury, subtract holdings of Government agencies and trust funds and of the Federal Reserve System.

[b]Bill holdings of agencies and funds and the Federal Reserve System are subtracted from total bills outstanding from the Treasury.

Source: Calculated from data in various monthly issues of the Federal Reserve Bulletin.

ten per cent of total bills outstanding.[212] However, changes in Federal Reserve System bill holdings are probably more important than the actual

[212]See Table 24.

levels. The Federal Reserve Open Market Account trades large quantities of bills contracyclically, and also exercise open market transactions to adjust for very short-term fluctuations in member bank reserves. These activities are described by Smith:

> In addition to their use to control credit in the interest of economic stability and growth, open market operations are carried on continuously for the purpose of offsetting the short-run effects on member bank reserves resulting from factors outside the control of the Federal Reserve--changes in float, currency in circulation, gold stock, Treasury and foreign deposits at the Reserve Banks, and so on.[213]

The Federal Reserve Open Market Account can initiate short-term reserve adjustments through direct bill transactions in the open market, through execution of repurchase agreements, or by not turning over maturing securities. Assuming equivalent quantities, these three methods have equal impact on the level of member bank reserves, although the effect of the repurchase agreement will be reversed upon termination of the agreement. The repurchase agreement would probably be used only for day to day changes, while direct transactions or run-offs would provide for longer-term or more permanent effects. However, run-offs are one-directional; _ceteris paribus_, if the System allows securities to run-off, the effect would be to increase the stock of securities available to the public. Assuming these operations were in the form of Treasury bills, the resulting increase in the stock of bills available to the public is identical for equivalent quantities of open market sales, sales of repurchase agreements, or the failure to renew maturing securities. Conversly, equivalent decreases in the stock of bills available to the public may be accomplished by an equal amount of open market bill purchases, or purchases of repurchase agreements.

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[213] Smith, "The Instruments of General Monetary Control," _op_. _cit_., p. 48.

The quantity of Federal Reserve System bill holdings on a monthly basis are available for the complete period in the Federal Reserve Bulletin presentation of the Treasury Department "Survey of Ownership."[214] Reported holdings of bills are inclusive of repurchase agreements, therefore the monthly first differences would measure net changes in bill holdings brought about by total monthly outright purchases and sales of bills, net repurchase agreements of bills, and bill redemptions. Federal Reserve System monthly bill holdings are shown in Table 27 for the period 1953-1964.[215]

The cyclical movements of System bill holdings are apparent as the quantities held in recessions are relatively high, while in periods of prosperity holdings are relatively low. Some upward trend is apparent, especially in the last few years.

However, it should be stressed that the monthly changes in System holdings do not occur smoothly during the month, but fluctuate both in direction of change and in magnitude over very short time periods. Clearly it would be desirable to know more about the timing and the magnitude of System transactions, but data on a within-month basis are not available. It is also evident that problems of specification occur when an attempt is

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[214] The Treasury Bulletin combines the holdings of the System with Federal agencies and trust funds, whereas the Federal Reserve Bulletin reports the holdings separately.

[215] These data are not directly comparable with the reported changes in holdings of bills in the "Transactions of the System Open Market Account" included in the Federal Reserve System Annual Report. Calculated changes in bill holdings from the two sources would differ by repurchase agreements in bills. Repurchase agreements are listed as a separate category in the Annual Report of the System, but are not subdivided by type of security.

TABLE 27.--Federal Reserve System holdings of Treasury bills, monthly 1953-1964. (in millions of dollars)

Month	1953	1954	1955	1956
January	652	1,918	1,160	578
February	584	1,788	883	543
March	515	1,911	891	734
April	589	1,911	886	403
May	830	2,091	941	538
June	1,455	1,455	886	855
July	1,672	2,993	1,261	550
August	1,772	1,302	1,039	947
September	1,943	1,549	1,104	742
October	2,056	1,660	1,303	850
November	2,319	2,167	1,278	1,415
December	2,993	2,204	1,722	1,918

Month	1957	1958	1959	1960
January	532	595	1,661	1,463
February	143	504	1,323	1,199
March	319	893	1,496	1,263
April	434	946	1,670	1,557
May	353	1,426	1,904	2,019
June	287	2,703	2,032	2,513
July	344	1,569	2,475	2,879
August	801	1,345	2,666	2,753
September	577	985	2,562	2,978
October	574	1,401	2,601	3,212
November	814	2,095	2,894	3,172
December	1,220	2,248	2,626	3,217

Month	1961	1962	1963	1964
January	2,524	3,032	2,262	3,312
February	2,596	2,830	2,542	3,728
March	2,327	3,105	2,583	4,295
April	2,483	3,152	2,664	3,626
May	2,652	3,167	2,721	4,642
June	2,840	2,961	3,364	5,171
July	2,443	2,834	3,600	5,388
August	2,659	3,079	3,175	5,112
September	2,970	2,373	3,320	5,067
October	3,242	2,516	3,504	5,353
November	3,742	2,445	4,199	6,419
December	3,349	2,723	4,146	6,487

Source: Various issues of the <u>Federal Reserve Bulletin</u>.

made to correlate the average monthly bill rate with the stock of bills available to the public at the end of a monthly period. The timing of quantity changes during the period could be such as to indicate no change between two month-end periods when significant trading took place between month-ends. Whether or not very short-term fluctuations in bill holdings by the System indicate flow or stock goals is still questionable.

Subtracting end-of-month System bill holdings and Federal agency and trust fund holdings from the total quantity outstanding from the Treasury provides the quantity of bills available to the public to hold.

The Quantity of Bills Available to the Public

The quantity of bills available to the public is the result of the decisions of the Treasury in managing the Federal debt, and of the Treasury and Federal Reserve System in carrying out their respective open market operations. Table 28 presents the stock of bills in the hands of the public, monthly, 1953-1964.[216] These values will be used in the regression equation estimates in the following Chapter.

The movement in the quantity of bills in the hands of the public over the cycle is illustrated in Chart 14, with the quantities for the three cycles centered at the National Bureau of Economic Research cyclical troughs, covering the 18 months preceding and following the trough. This has been done in order to compare bill quantity movements with the bill rate movements shown above in Chart 2. Generally the rate movements over

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[216] These bill quantities have been published in this form since 1962 in the Federal Reserve Bulletin. Prior data have been calculated by subtraction from total bills.

TABLE 28.--Treasury bills in the hands of the public, monthly, 1953-1964 (in millions of dollars)

Month	1953	1954	1955	1956
January	20,851	17,421	18,243	21,210
February	20,959	17,573	18,559	22,279
March	18,509	19,013	18,561	19,713
April	18,593	20,015	18,556	20,104
May	18,927	19,589	18,538	19,965
June	18,146	17,954	18,588	19,680
July	18,451	16,417	18,649	20,020
August	18,380	18,170	19,242	19,682
September	17,481	17,918	19,667	19,889
October	17,360	17,787	19,397	21,328
November	17,089	17,279	19,215	22,937
December	16,416	17,251	20,253	23,119

Month	1957	1958	1959	1960
January	24,449	26,335	28,591	39,167
February	25,425	25,402	30,304	39,597
March	24,758	21,887	30,540	35,451
April	24,703	21,148	32,472	35,284
May	26,299	20,654	32,962	34,962
June	23,003	19,530	29,899	30,531
July	25,973	20,653	34,368	32,974
August	27,265	20,932	35,807	33,047
September	25,934	21,564	34,445	32,958
October	25,874	24,404	36,380	35,563
November	25,709	26,959	35,930	35,602
December	25,507	27,378	36,757	35,638

Month	1961	1962	1963	1964
January	36,572	39,988	45,642	47,686
February	36,672	40,550	46,232	48,352
March	33,856	38,848	44,718	46,974
April	34,885	39,318	45,718	46,443
May	34,954	39,661	45,817	46,318
June	33,082	38,276	42,724	44,110
July	37,663	39,001	42,676	44,569
August	37,629	39,863	43,074	45,722
September	38,338	39,258	43,975	47,058
October	38,645	42,700	45,252	48,607
November	38,935	44,348	45,074	48,803
December	39,512	44,662	46,027	48,682

Source: Federal Reserve Bulletin, various monthly issues.

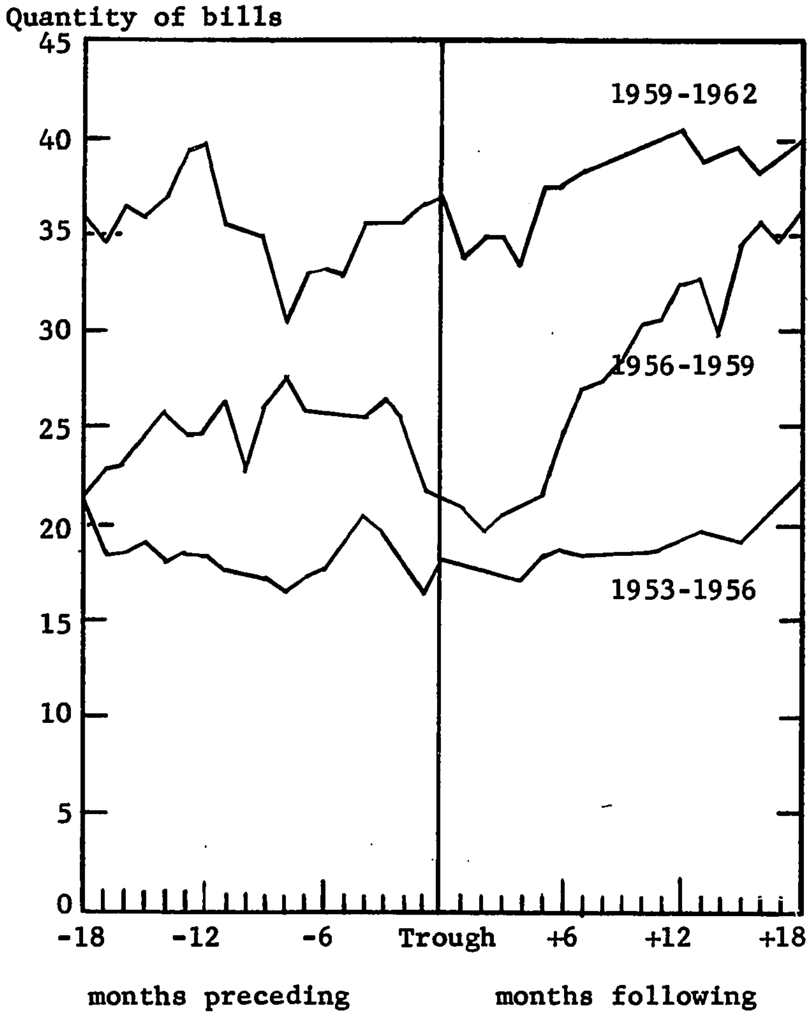

Chart 14.--Quantity of bills in the hands of the public in three cycles with the troughs centered, and quantities measured 18 months preceding and following.

the cycle are in the same direction as the quantity movements--the direction indicated by the simple model of Chapter V. In the following Chapter the bill rate will be regressed on the quantity of bills in the hands of the public.

For some of the multiple regressions in the following Chapter, the quantity of marketable Federal debt, other than Treasury bills, in the hands of the public and within one year of maturity will be used as an independent variable. Table 29 provides the monthly quantities of non-bill marketable securities having less than one year to maturity. These securities have been considered close substitutes for bills, and possibly changes in the quantities of non-bill debt within one year to maturity affect the bill rate. The values in Table 29 are available only from 1953, whereas the bill quantities were available from 1952. Prior to 1953, within-one-year securities were classified to first call instead of final maturity. Changes in these monthly values are seen to be more volatile than monthly changes in Treasury bills, and there appears to be some seasonality to the movement. Since August, 1962, the quantity of non-bill marketable debt due within one year in the hands of the public has declined by $20 billion, whereas over the same period the quantity of bills in the hands of the public increased by approximately $10 billion.

Summary

The quantity of Treasury bills available to the public is dependent on Treasury debt management decisions, and Treasury and Federal Reserve System open market operations. Over the period 1952-1964, the quantity of bills in the hands of the public has increased markedly while the quantity of non-bill debt due within one year showed no strong trend until a rather sharp decline in the period since mid 1962.

TABLE 29.--Federal marketable securities, other than bills, having less than one year to maturity, monthly, 1953-1964. (in millions of dollars)

Month	1953	1954	1955	1956
January	21,680	39,812	26,054	19,330
February	20,928	30,253	15,852	18,189
March	25,355	29,379	15,838	17,616
April	25,356	29,964	19,047	17,562
May	25,217	27,368	16,848	22,591
June	30,775	27,319	13,636	17,865
July	36,666	28,065	15,622	13,885
August	36,554	17,020	19,675	23,935
September	33,254	26,911	19,668	22,925
October	33,276	26,929	22,681	23,038
November	33,297	29,524	22,440	22,534
December	39,672	26,091	19,214	22,397
Month	**1957**	**1958**	**1959**	**1960**
January	22,500	26,401	23,567	22,017
February	20,959	27,782	20,098	18,929
March	20,969	28,158	16,628	19,260
April	21,456	27,856	16,678	19,376
May	19,715	31,721	21,420	17,976
June	26,616	24,343	21,442	17,996
July	27,291	24,238	21,324	18,004
August	23,544	25,853	19,710	18,191
September	24,461	24,020	19,749	20,339
October	24,203	24,003	19,922	20,267
November	24,071	24,961	21,977	21,308
December	26,198	23,522	22,008	21,487
Month	**1961**	**1962**	**1963**	**1964**
January	21,609	26,089	23,290	17,114
February	24,127	29,058	23,208	16,213
March	23,847	28,995	17,338	16,201
April	25,441	29,445	17,203	16,195
May	26,784	30,335	19,232	17,462
June	30,205	29,797	19,231	17,463
July	30,028	29,688	19,201	12,913
August	26,935	34,331	22,087	13,997
September	26,813	26,789	18,321	13,997
October	27,315	26,580	18,304	13,826
November	24,178	23,512	18,954	16,685
December	26,014	23,290	18,952	16,650

Source: Federal Reserve Bulletin, various monthly issues.

The Treasury has followed no consistent debt management policy over this period, and due to the pressures of financing new debt and refinancing maturing debt, has been guided by the important objective of raising the money to meet the needs of the Government at low interest cost, while slighting other objectives such as an "optimum" maturity structure or contracyclical management. However, the recent goal of raising short-term interest rates on Federal securities, or Operation Twist, seems to have been rather successful.[216]

The Federal Reserve System, through open market operations, is important on two separate accounts. First, the policy of "bills-only" in the period 1953-1961 has caused cyclical movements in the quantity of bills available to the public, and even since 1961 open market transactions in bills have remained relatively large. Second, the System is a very large holder of Federal marketable short-term debt other than bills, and has acted to reduce the quantity of bill-substitutes available to the public.

Whether or not the behavioral goals of the Treasury and the System are framed in terms of stocks or flows is uncertain. However, since the available data are end-of-month values, and since expressing the variables as successive differences does not necessarily measure flows, the stock relations are those which will be estimated in Chapter VII.

The determination of the stock of bills has been discussed at some length. Now the stock of bills, the stock of other within-one-year marketable debt, and the transactions of the Federal Reserve System presented in this Chapter will be used as independent variables in attempting to measure the movements of the bill rate discussed in relation to the simple demand model of Chapter V.

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[216] Harry G. Johnson, "Major Issues in Monetary and Fiscal Policies," _op_. _cit_., pp. 1409-1410.

CHAPTER VII

RELATIONSHIPS BETWEEN THE BILL RATE AND THE STOCK OF BILLS

Introduction

The last several chapters have described the dependence of the Treasury bill rate on the stock of bills and the reserve (or total) demand schedule. At this point it is necessary to state more specifically the relationships already discussed in order to attempt to make some meaningful empirical estimates of the slope and position of the total demand schedule. Since the stock of bills has been defined as perfectly interest inelastic, movements in the stock of bills over successive time periods would trace out the demand schedule, if there were no change in demand (or any other relevant variable).

A stable demand schedule with changing stocks is illustrated in Chart 15-A.[217] The observed bill rates and the corresponding stock values identify the demand schedule. The B portion of Chart 15 illustrates the

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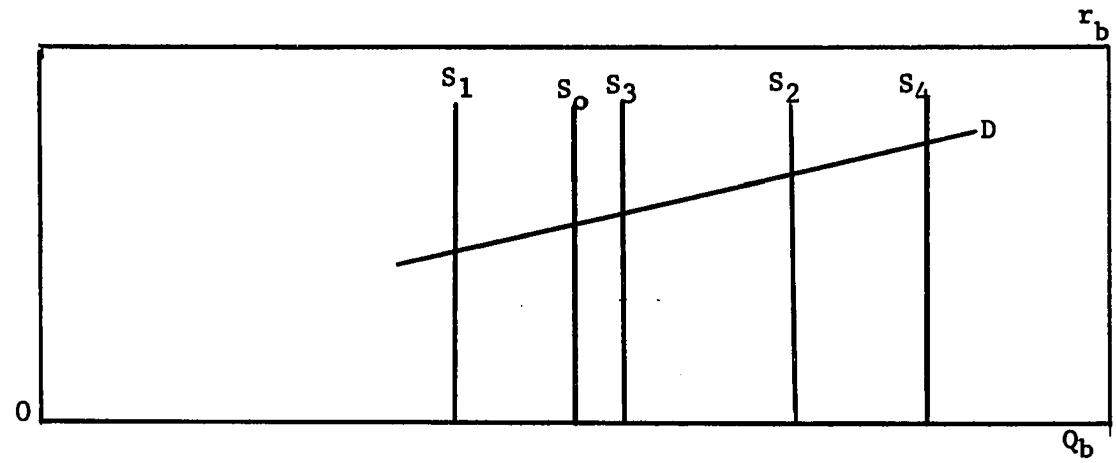
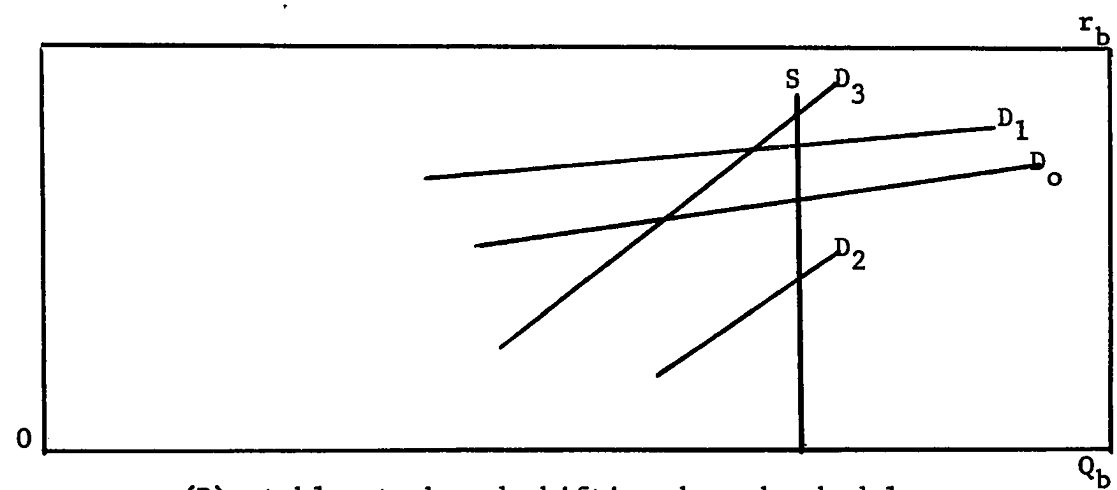
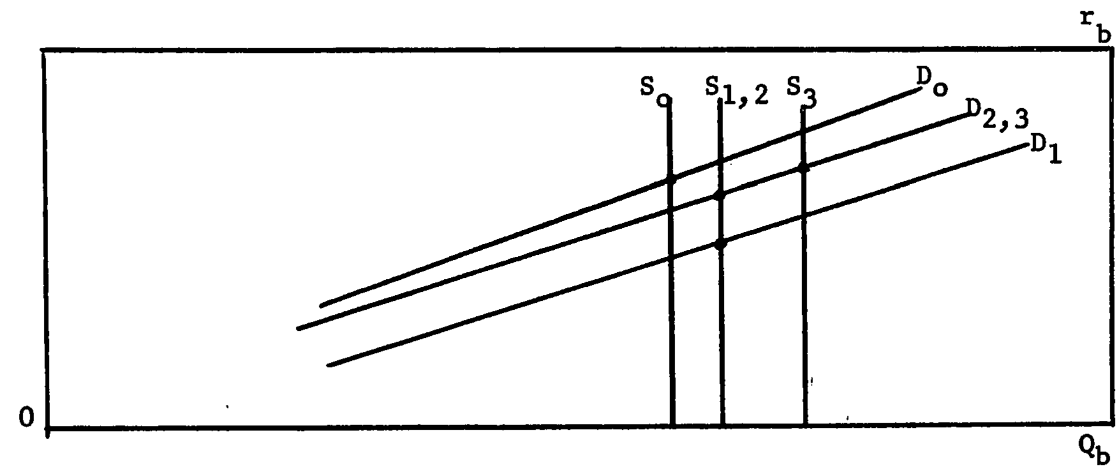
[217]This figure simply restates the problems discussed in: E. J. Working, "What Do Statistical Demand Curves Show?" Reprinted in American Economic Association <u>Readings in Price Theory</u> (Chicago: Richard D. Irwin, Inc., 1952), pp. 97-115. Also see: Lloyd A. Metzler, "The Assumptions Implied in Least Squares Demand Techniques," <u>The Review of Economic Statistics</u>, Vol. XXII, No. 1 (February, 1964), pp. 38-149.



(A) stable demand schedule and changing stocks



(B) stable stock and shifting demand schedule



(C) changing stock and shifting demand schedule

Chart 15.--Hypothetical reserve demands schedules and stocks.

situation of a constant stock of bills and changing demand, with the intersections of the demand schedules with the constant stock providing rate observations along the stock. This approach, however, does not provide any information regarding the shape of the demand schedule. The C part of the illustration indicates the most likely situation, that is, when there are changes in both the stock and the demand schedule. In correlating the bill rate with the stock, the degree of success in measuring the demand schedule depends, in part, on the stability of the schedule. The stability of the demand schedule, of course, is dependent on the reactions of a diverse group of holders (or potential holders) to changes in all other relevant economic variables.[218] A change in a particular variable probably will not be equally important to each sector--or even to individual units making up a single sector--or to the same sector at different points in time. However, since it has been argued that it is reasonable to think in terms of "the demand for Treasury bills," it seems reasonable also to attempt to measure the total demand schedule.[219]

There are both statistical and economic difficulties involved in measuring the demand schedule, and these should be stated as specifically as possible at the outset.

(1) Changes in the stock of bills do not occur randomly in direction and magnitude as indicated in Chart 15-A. Instead, as pointed out earlier, when a decision is made to increase the quantity of bills

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[218]Demand by the most important economic sectors is discussed in the following Chapter.

[219]Disaggregation may indeed offer important insights relative to the demand schedule, but too much disaggregation may reduce the problem to an uninteresting maze.

outstanding from the Treasury, small weekly increases are usually stretched out over a period of 13 or 26 weeks. Also, Federal Open Market Committee contracyclical transactions are generally in the same direction for a period of several months. During the period 1952-1964, a significant upward trend in the quantity of bills is apparent. The definite upward trend on the quantity of bills indicates that autocorrelation of residuals may present a problem if the quantity is used as an independent variable in explaining the bill rate.

(2) The bill rate is sensitive to many macroeconomic variables, which are not measured on a monthly basis (gross national product, flow of funds, etc.). Although many different variables affect the bill rate, the position taken here is one provided by Fellner and Somers, that:

> ...in a multidimensional system there are a great many factors that affect the interest rate. However, in _any_ system, these factors can affect the market rate of interest only through their effect on the demand and supply of interest-bearing securities.[220]

Therefore, even with a permanent bill stock, changes in the bill rate would be expected to occur frequently due to demand shifts. Since the demand schedule does change, a problem arises as to the period over which it should be measured. The complete period 1952-1964 is surely too long. On the other hand, a period of 12 months may be too short (or too long). The statistical problem of degrees of freedom enters if multiple regression is attempted for a period as short as 12 months. Also, the bill rate is closely related to other interest rates and all rates move in the same direction cyclically, along with many other macroeconomic variables.

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[220] William Fellner and Harold M. Somers, "Stock and Flow Analysis: Comment," _Econometrica_, Vol. 18, No. 2 (April, 1950), p. 244.

Moreover, even if the relevant variables remained constant, changing expectations could cause movements in the bill rate.[221] Generally, the statistical problems here are those of <u>specification</u> (the inclusion of all relevant variables in the proper functional form), and <u>multicollinearity</u> (the high degree of interrelationship among the "independent" variables).

(3) <u>A priori</u> information regarding the <u>form</u> of the relationships (linear, logarithmic, etc.) between the bill rate and other variables is generally not available. Therefore, attempts to determine the proper form of the relationships will be conducted on a trial and error basis. This requires subjectively evaluating various forms of regression equations on the basis of both economic and statistical criteria. A considerable amount of <u>a priori</u> information of a qualitative sort was developed in the earlier chapters in the description of the market, its participants, and the cyclical and seasonal movements of the rate. This information will be used in considering the observations for certain time periods for exclusion from the regression estimates. Of course, the subjective elimination of data makes much of the statistical inference from regression analysis meaningless; but as Fisher points out:

> Faced with choosing between a procedure which yields, at best, precise results of little or no meaning and one which yields meaningful results of little or no precision, it seems clear that the latter alternative represents the more hopeful course.[222]

Additional extraneous information is available from some recent empirical estimates which have included the bill rate as a dependent variable. A few of the more relevant studies are reviewed below.

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[221] See the discussion of the term structure of interest rates above in Chapter IV.

[222] Franklin M. Fisher, <u>op</u>. <u>cit</u>., pp. 21-22.

(4) Although it is expected that autocorrelation of residuals may violate the statistical assumptions of the classical regression model, a thorough analysis can be made only after the regression equations are calculated. Analysis of the residuals is necessary for evaluating the bias and efficiency of the estimates of the regression coefficients, the standard errors, and the coefficients of partial and multiple determination. Knowledge of the behavior of the residuals in the various empirical equations also provide additional extraneous information that is helpful in fitting further regression equations.

(5) Finally, evaluating the results of the fitted regression equations in meaningful economic terms requires blending the information gathered in the descriptive, theoretical, and statistical discussions.

This Chapter considers the above problems in greater detail, beginning with a survey of some recent empirical relationships. This is followed by a statement of the theoretically expected results. Finally, there is presented a discussion of the results and an evaluation of the fitted regression equations.

A Survey of Some Recent Empirical Estimates

Recently there have been several regression analysis studies using the Treasury bill rate, an index of rates on Federal securities, or some other short-term United States government marketable security rate as the dependent variable. The studies by Brown,[223] Robert Haney Scott,[224]

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[223] William H. Brown, Jr., "Seasonal Variations in Interest Rates," Tested Knowledge of Business Cycles, 42nd Annual Report of the National Bureau of Economic Research, 1962, p. 82; and "Seasonal Variations in Interest Rates," The Uses of Economic Research, 43rd Annual Report of the National Bureau of Economic Research, pp. 79-81, 1963.

Turvey,[225] and Okun[226] are particularly interesting and relevant, and therefore, will be briefly discussed.

Brown's results have not been published in full, but preliminary reports on his investigation of seasonal variations in interest rates have indicated that "the primary cause of the seasonal in the short-term market is the seasonal imbalance in Treasury receipts,"[227] which is, presumably, brought about by the variations in the short-term debt outstanding from the Treasury. Brown's list of possible explanatory variables indicates that probably both the demand for, as well as the supply of bills are being investigated.

Scott, in his empirical study, attempts to explain the bill rate, the rate on Federal marketable securities maturing in ten or more years, and debits to demand deposits, monthly from 1952 through 1959. His attempts to explain the bill rate utilize the following independent variables: debits to demand deposits at 337 reporting centers; change in net free reserves; currency outside of banks and demand deposits; time deposits; total Federal securities in the hands of the public; and average maturity of the marketable debt. Scott's multiple linear regressions, using levels of the variables, provide coefficients of multiple determination of

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[224] Robert Haney Scott, "An Empirical Look at Debt Management," 1961 Proceedings of the Business and Economic Statistics Section of the American Statistical Association, pp. 130-137, and "Liquidity and the Term Structure of Interest Rates," The Quarterly Journal of Economics, Vol. LXXIX, No. 1 (February, 1965), pp. 135-145.

[225] Ralph Turvey, Interest Rates and Asset Prices, op. cit.

[226] Arthur M. Okun, "Monetary Policy, Debt Management and Interest Rates," op. cit., pp. 331-380.

[227] Brown, 43rd Annual Report, op. cit., p. 80.

between .70 to .83, with the theoretically expected signs. Another interesting series of regressions were calculated using the difference between the bill rate and the "over 10 year rate" (r_{10} - r_b) as the dependent variable. Scott's principal concern was in measuring the effect on the dependent variables relative to changes in the average time to maturity of the marketable debt. An important conclusion, supported by his empirical estimates, is that Treasury debt management policies <u>are</u> responsive to changes in the levels of the macroeconomic variables, and in a footnote he states, "no longer can the behavior of those in charge of policy be treated as an exogenous force since they pursue certain policies on the basis of other relevant economic magnitudes."[228] If this conclusion is correct, the "exogenously" determined stock of bills in Chart 10 of the analysis above may not be perfectly inelastic relative to the bill rate. Although Scott cautions readers that classical least squares probably will yield biased estimates, he provides no analysis of residuals.[229]

Turvey uses as a dependent variable a weighted mean of interest rates on the following Federal marketable securities; Treasury bill, 9-12 month, 3-5 year, and long-term issues, with weights roughly comparable to the maturity structure of public holdings.[230] His independent variables comprise: total Federal obligations and guaranteed debt; money and savings

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[228] Scott, "An Empirical Look at Debt Management," <u>op</u>. <u>cit</u>., p. 133.

[229] However, he does fit one small system of simultaneous equations in an attempt to obtain an unbiased explanation of the average time to maturity.

[230] Turvey, <u>op</u>. <u>cit</u>.: these comments and those following are detailed in his Chapter VI, pp. 60-78.

bonds less bank loans; the monetary sector's holdings of long-term debt; a rate on time deposits; national income; the implicit price index; and turnover of bank deposits. Year-end quarterly values from 1945-1951, and all quarterly values from 1952-1957 were the basis of the observations. The general hypotheses, later supported by regression equations having high coefficients of multiple determination, were listed as:

> ...the average yield of Federal obligations...*ceteris paribus*, ...will be: (a) lowered by an increase in the sum of the quantity of money and the amount of savings bonds less the amount of bank loans outstanding; (b) raised by an increase in the quantity of Federal obligations outstanding; (c) lowered by an increase in the monetary sector's holding of long-term debt, since such an increase would lower interest rates on long-term debts and these are substitutes for Federal obligations; (d) raised by an increase in the interest rates paid on time deposits, postal savings deposits and savings bonds and charged on bank loans; (e) either raised or lowered by an increase in the income from real assets, the assumptions made do not enable us to say which; (f) raised by an increase in the national income, given the income from real assets.[231]

Turvey then lists four possible cuases for shifts in demand: (1) change in expectations, (2) development of new forms of debt, (3) alternation of the maturity structure of the Federal debt or other changes in the quality of Federal obligations, and (4) change in the tax structure.[232]

His regression equations, using various combinations of the independent variables expressed as levels or as ratios, have the proper algebraic signs in almost every case, with coefficients of multiple determination between .92 and .96. Turvey has presented these results as an example of his theoretical propositions. There is no statistical analysis of residuals or multicollinearity, which makes an evaluation of the results difficult.

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[231] *Ibid*., pp. 66-67.

[232] *Ibid*., pp. 67-68.

Okun's study, like that of Turvey, uses a quarterly time period and similar independent variables.[233] Okun uses alternatively the bill rate and a long-term Government bond rate as dependent variables. Without describing the independent variables in detail, they include, generally: various measures of the money supply; the quantity of marketable debt in the hands of the public divided into within one year, one to five years, and more than five years maturity categories; the average time to maturity of these instruments (which was excluded from most of his bill rate estimates due to poor fits); modified gross national product; and net private wealth. Okun's estimates also make use of quarterly dummy seasonal variables which indicated the presence of quarterly seasonality in the bill rate. The coefficients of multiple determination range from .80 to over .90. Although he presents no extensive statistical analysis of his results, he does point out that there is a high degree of autocorrelation of residuals, and specifically qualifies his empirical results. The results of his multiple regression equations are refined by the introduction of his estimated "potential" gross national product. The application of his results to monetary and debt management policy in the period 1946-1959 illustrate the importance and need for even the roughest type of empirical estimation.

All four of these studies include some type of variable measuring the stock of debt, with Turvey using the most inclusive measure--Federal obligations outstanding including guaranteed debt. Scott, on the other hand, uses total Federal debt held by the public; Okun divides the marketable debt in the hands of the public into three maturity categories; and

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[233] Okun, "Monetary Policy, Debt Management and Interest Rates," op. cit.

Brown apparently is utilizing short-term marketable debt and Treasury bills (both outstanding and in the hands of the public). Also, the money supply, in one form or another, is a common variable. In addition, Brown evidently is experimenting with ownership data for the Federal Reserve System and commercial banks. Okun and Turvey, using quarterly time periods, include a measure of gross national product in their lists of independent variables.

The use of monthly time periods prohibits the employment of gross national product since it is only estimated quarterly. Because of this problem, several important studies have been excluded from this brief review. The studies by Latané,[234] Bronfenbrenner and Mayer,[235] Stedry,[236] Christ,[237] and others who have measured forms of the liquidity preference function using the money supply, gross national product, or a combination of these variables forming income velocity, are therefore not discussed.

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[234] Henry A. Latané, "Cash Balances and the Interest Rate--A Pragmatic Result," Review of Economics and Statistics, Vol. XXXVI, No. 4 (November, 1954), pp. 456-460.

[235] Martin Bronfenbrenner and Thomas Mayer, "Liquidity Functions in the American Economy," Econometrica, Vol. XXVIII, No. 4 (October, 1960), pp. 810-834.

[236] Andrew C. Stedry, "A Note on Interest Rates and the Demand for Money," Review of Economics and Statistics, Vol. XLI, No. 3 (August, 1959), pp. 303-307.

[237] Carl F. Christ, "Interest Rates and 'Portfolio' Selection Among Liquid Assets in the U. S.," (Ed.) Christ, Measurement in Economics, Studies in Mathematical Economics and Econometrics in Memory of Yehuda Grunfeld (Stanford: Stanford University Press, 1963), pp. 201-218.

A Discussion of Independent Variables and Their Expected Effect on the Bill Rate

The monthly average of daily closing rates on Treasury bills is the dependent variable throughout the following regression calculations. It has been argued that the bill rate is dependent on the demand for bills to hold and the bill stock. In this Chapter, emphasis is placed on the relationship between the bill rate and the stock of bills; therefore, those factors causing the demand schedule to shift will be treated rather lightly. The principal reason for proceeding in this fashion is to gain some insight into the degree of flexibility of the reserve demand schedule (the schedule defined above in Chapter V). If the demand schedule is relatively stable, a large portion of the variation in the bill rate should be explained by changes in the stock of bills. Conversely, if the relationship between the bill rate and the stock of bills is of a low degree, then it is necessary to seek the causes of bill rate movements on the demand side.

It would be naive indeed, to postulate the determinants of the bill rate as a single variable, for instance the stock of bills. It has been shown that the bill rate is closely related to the interest rate yielded on most other securities in the economy. In fact, it may be found that an attempt to explain the movements in the bill rate on a monthly basis with simple demand and stock variables is not possible, and the explanation should be explored on a higher (or lower) level of aggregation.

In order to avoid spurious relationships between the bill rate and the stock of bills, other independent variables will be included in the regression estimates in order to view the relationship between the bill rate and the bill stock when the other variables are "held constant" in the multiple regression sense (which corresponds roughly with the assumption, in theoretical propositions, of ceteris paribus).

According to the framework of Chapter V, the bill rate should be positively related to the stock of bills; or, ceteris paribus, changes in the bill rate should be in the same direction as changes in the quantity of bills. Assuming the demand schedule remains constant, other debt variables also are expected to influence the bill rate. In Table 30, debt variables are listed with the expected direction of effect on the bill rate, positive (increase in the variable increases the rate, decreases in the variable decreases the rate), or negatively (increases in the variable decreases the rate, decreases in the variable increases the rate). Symbpls, which will be utilized in reporting the regression results, are indicated with the independent variables.

Independent variables which are expected to cause the bill rate to change in the same direction include: the quantity of bills and the quantity of non-bill Federal marketable debt within one year to maturity (whether or not agency and trust fund holdings and Federal Reserve System holdings are included), and the average maturity of the marketable Federal debt outstanding. Since non-bill marketable debt within one year to maturity is viewed as a close, although not a perfect, substitute for bills, an increase in the quantity of non-bill debt due within one year is expected to cause the bill rate to increase--assuming the bill stock remains constant. However, if the Treasury debt management operation is in the form of a "swap," an equal amount of non-bill debt within one year of maturity for bills (or vice-versa), the reaction of the bill rate would be

TABLE 30.--Independent debt variables and the expected direction of association with the bill rate

Symbol	Variable	Direction of effect on bill rate, (+) positive, (-) negative
Q_b	quantity of bills issued by the Treasury less agency and trust fund holdings	+
Q_1	quantity of non-bill Federal marketable debt within one year to maturity issued by the Treasury	+
Q	total quantity of Federal marketable debt within one year to maturity ($Q_b + Q_1$)	+
A_b	Federal agency and trust fund holdings of bills	-
S_b	Federal Reserve System holdings of bills	-
q_b	quantity of bills in the hands of the public ($Q_b - A_b - S_b$)	+
q_1	quantity of non-bill Federal marketable debt within one year to maturity in the hands of the public ($Q_1 - A_1 - S_1$)	+
$\overline{m}$	average time to maturity of the marketable Federal debt issued by the Treasury	--

expected to: (a) increase slightly if the swap increases the quantity of bills, or (b) decrease slightly if the swap decreases the bill stock. The average maturity of the Federal marketable debt is not truly an independent variable since its value depends on the relative quantities of securities in each maturity category and the passage of time. Holding other quantities of Federal debt constant, an increase in the quantity of bills would reduce the average maturity value. If no Treasury debt management operations took place within a one-month period, the average maturity would decrease by one month. Okun, above, utilized the average maturity of Federal marketable debt to smooth out the effect of blocs of securities falling into shorter-term maturity categories due to the passage of time. A more appropriate variable for purposes here would be the average maturity of the "over one year to maturity" Federal marketable debt <u>in the hands of the public</u>. Such a variable, however, would be difficult to construct.

Variables whose direction of change would cause the bill rate to move in the opposite direction are: Federal Reserve System holdings of bills and Federal agency and trust fund holdings. Increases in these variables are viewed as decreasing the stock of bills available to the public. Therefore, an increase in bill holdings by either of these sectors is expected to cause the bill rate to decrease (a decrease in bill holdings by the sectors--increase in the bill rate). Regression equations are fit using System holdings as a separate independent variable, and using the quantity of bills issued by the Treasury less System and trust fund holdings. Federal agency and trust fund holdings are not included in any of the regressions as an independent variable, but are <u>always</u> subtracted from the quantity of bills issued by the Treasury. The estimated value of the regression coefficient for quantity changes in the stock of bills should be relatively small, but it should be expected that the regression coefficient for the quantity of bills will be near in value to the regression coefficient for the bill holdings by the Federal Reserve System. If changes in System holdings operate to change the demand for bills within the monthly time period, the coefficient for System holdings may be slightly larger than the coefficient for the bill stock.

In addition to the debt variables on the supply side, some aggregate measures from the demand side are included in some of the regression estimates. Federal Reserve System bill holdings lagged one period are included with current System holdings, on the assumption that System transactions in the last monthly period would affect demand for bills in the current period. Decreased holdings last period would be expected to increase the private sector's demand for bills in the current period causing a downward effect on the bill rate. Decreases in demand are expected to have an upward effect on the bill rate. In addition to System holdings lagged one period, the selected demand variables and the expected positive or negative association with the bill rate are included in Table 31.

TABLE 31.--Selected independent aggregate demand variables and the expected direction of association with the bill rate

Symbol	Variable	Direction of effect on bill rate, (+) positive, (-) negative
R	free reserves of member commercial banks ($R_1 + R_c$)	-
R_1	free reserves of New York, Chicago, and Reserve City banks	-
R_c	free reserves of country banks	-
D	demand deposits	-
DT	time deposits	-
T	Treasury deposits in commercial banks	+ or -

Free reserves of member commercial banks (required reserves less borrowing from the Federal Reserve System) provide an indication of the ability of the commercial banking sector to increase holdings of bills, and reflect general monetary policy and macroeconomic conditions. However, free reserves are automatically reduced, ceteris paribus, with bill purchases by commercial banks. The bill rate and the level of free reserves are inversely related, but the directness (and direction) of causation is not clear. Meigs, for example, states:

> The evidence considered here indicates that the desired free-reserve ratio of the member banks is functionally related to market interest rates. The scatter diagrams with annual data and all of the regressions with monthly data suggest that market interest rates--the Treasury bill rate in particular--have a strong influence upon the free-reserve ratio....
>
> An alternative hypothesis...would attribute the observed correlations not to be influence of interest rates upon the desired free reserve ratios of banks but instead to the influence of free-reserve ratios upon interest rates.[238]

It is expected that the relationship between changes in free reserves and changes in System bill holdings would be inversely related. Free reserves, as an independent variable, will be viewed in greater detail in the next Chapter in relation to commercial bank holdings of bills.

Free reserves are expected to be positively related with the money supply, and therefore the bill rate is expected to be negatively related to the money supply. Increases in the supply of demand deposits (or time deposits, ceteris paribus, would be indicative of increased demand for bills, therefore, a lower bill rate. Okun's results (above) in explaining the bill rate with "money" variables on a quarterly basis generally were not satisfactory, and it is probable that monthly estimates will yield even worse results.

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[238] Meigs, op. cit., p. 82. Also, Eugene M. Lerner in "A Criticism of Free Reserves," The Review of Economics and Statistics, Vol. XLIV, No. 2 (May, 1962), pp. 225-228; brings the discount rate into the relationship: "Free reserves move countercyclically because of the lagged relationship between the discount rate and the Treasury bill rate." Also relevant is: William H. White, "Regulation of Short-Term Interest Rates Through Monetary Action," International Monetary Fund Staff Papers, Vol. X, No. 2 (July, 1963), pp. 299-320.

Treasury demand deposits are included here on an experimental basis. Brown's results (above--and as yet unpublished) have indicated that seasonal imbalance in the receipts of the Treasury are responsible for the seasonality of the bill rate. If the seasonality in receipts is reflected in seasonality in the quantity of bills issued by the Treasury, then the effect on the bill rate should be measured by movements in the quantity of bills. On the other hand, Treasury deposits may affect the demand for bills by commercial banks. If the commercial banks holding Treasury deposits view these deposits as volatile and temporary, and hold bills to cover the deposits, bill holdings of commercial banks will fluctuate with Treasury deposits.[239] If Treasury receipts are low relative to expenditures and the stock of bills increases, the bill rate would tend to rise. But if receipts from additional bill sales are deposited in commercial banks, free reserves increase, allowing banks to increase the demand for bills which would put downward pressure on the rate.

It is apparent from the discussion that there are significant interrelationships among the independent variables, and a system of structural equations would probably come nearer providing unbiased estimates of the effect of these variables on the bill rate. A system of behavioral equations, however, would necessitate a general-equilibrium approach to explain the behavior of variables which are considered exogenous in the partial-equilibrium approach. Only ordinary least squares techniques are utilized in the calculation of the relationships of these variables with the bill rate. The results of these attempts follow.

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[239] For a detailed description of Treasury deposit balances and the influence on bank reserves, see: Ernest Block, "The Treasury's Deposit Balances and the Banking System," Essays in Money and Credit, Federal Reserve Bank of New York, 1964, pp. 19-24.

Regression Results Emphasizing Supply Variables

The first group of independent variables used in "explaining" the average monthly market bill rate are: the quantity of Treasury bills in the hands of the public (q_b), the quantity of marketable Federal debt within one year of maturity in the hands of the public (q_1), the average time to maturity of the marketable debt ($\bar{m}$), and time (t) in months. The time period of the regressions in this Chapter cover 142 months, beginning January, 1953, and ending with October, 1964.

The results of the regressions utilizing the variables described above are summarized in Table 32. The Table includes the constant, the regression coefficients, standard errors of the regression coefficients (in parenthesis below the coefficient), the coefficient of determination (R^2), the residual variance (σ_u^2), the Durbin-Watson statistic (d'), and the first-order coefficient of autocorrelation of the calculated residuals (r').[240] In addition, a matrix of simple correlation is shown.

The bill rate is measured in per cent (2.57), the average maturity in months (72.0), and time in months also. The debt quantity variables are measured in billions of dollars (20.562). Measuring dollar variables in billions of dollars is kept consistent throughout the regression results presented in this Chapter and the next (free reserves, demand deposits, and non-financial corporation holdings of bills are examples).

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[240] The computer program used for these calculations (discussed above on pages 147-148) has been carefully checked for accuracy and the results presented are accurate to the place rounded. Some of the calculations reported below were performed with a different program and have a degree of computational error. The calculations performed on this other program are so indicated.

TABLE 32.--Results of regressions of the Treasury bill rate on combinations of: the quantity of bills in the hands of the public (q_b), the quantity of marketable Federal debt within one year to maturity in the hands of the public (q_1), the average time to maturity of the marketable debt ($\overline{m}$), and time (t) in months[a]-January, 1953-October, 1964

Equation (number) and constant	Regression coefficients and (standard errors)				R^2	σ_u^2	d'	t'
	q_b	q_1	$\overline{m}$	t				
(1') .7995	.0571 (.0052)				.46	.90	.13	.94
(2') 1.8698	.0504 (.0053)	-.0375 (.0100)			.51	.86	.18	.91
(3') 6.8552	.0326 (.0055)	-.0571 (.0095)	-.0672 (.0109)		.62	.77	.24	.88
(4') 6.5706	.0698 (.0153)	-.0594 (.0092)	-.0686 (.0107)	.0099 (.0038)	.64	.76	.29	.85
(5') .4737	.0851 (.0180)			-.0073 (.0049)	.47	.80		

Matrix of simple correlation coefficients

	r_b	q_b	q_1	$\overline{m}$	t
r_b	1.000				
q_b	.680	1.000			
q_1	-.439	-.340	1.000		
$\overline{m}$	-.508	-.442	-.113	1.000	
t	.623	.958	-.348	-.428	1.000

The regression coefficients in Table 32 indicate that an increase of one billion dollars in the quantity of bills in the hands of the public will increase the Treasury bill rate by between .03 and .08 per cent points. The algebraic sign is positive, as expected, but the standard error of the regression coefficients are underestimated because of the high degree of positive autocorrelation of the calculated residuals indicated by the relatively small value of the Durbin-Watson statistic (d'), and the relatively large value of the calculated first-order correlation coefficient (r'). There is a very strong positive relationship between the quantity of bills and time as shown by the simple correlation coefficient between the two variables of .958. In equation number (5'), when the bill rate is regressed on the quantity of bills in the hands of the public and time, the partial regression coefficient with time becomes negative. Equation (5') was calculated experimentally to see if the relationship between the bill rate and the quantity of bills would be lessened by the inclusion of time as a specific variable. Simple linear relationships were calculated on a twelve month basis between the bill rate and the quantity of bills in the hands of the public, but the results were not very encouraging. The regression coefficients were generally positive, but the values showed little consistency.

The algebraic sign for the quantity of Federal marketable debt within one year to maturity (other than bills) in the hands of the public was negative, whereas the expected sign was positive due to the assumed high degree of substitutability between bills and other short-term Government debt in holders' portfolios. The negative sign is brought about by the negative trend over time of the quantity of less than one year (non-bill) marketable debt, while the bill rate maintained a positive trend.

Linear regression of the bill rate on the quantity of bills and the quantity of other marketable debt maturing within one year for 24 month periods were calculated. The results were not very meaningful, with the algebraic signs of the partial regression coefficients for the quantity of non-bill debt maturing within one year mixed--half positive and half negative.

The algebraic sign of the regression coefficient for the average maturity of the marketable debt was negative, as expected. The simple correlation coefficients between the average maturity variable and bill quantity was negative, as was the sign of the average maturity with the within-one-year debt quantity relationship--indicating that the average maturity tends to vary inversely with the quantity of short-term debt.

Probably the most significant results of the estimates of Table 32 is the finding of the high degree of autocorrelation of residuals. The calculated Durbin-Watson statistic should be in the vicinity of 1.60 in order for there to be no indication of positive autocorrelation of residuals at the five per cent level of significance. The calculated $\underline{r'}$ values indicate that first-differencing the monthly values may be appropriate in this case.

Table 33 shows the results of measuring the simple and multiple relationships between monthly changes of the variables and the variables expressed as natural logarithms. The regressions with monthly changes indicates that a one billion dollar increase in the quantity of bills in the hands of the public would result in a bill rate change of slightly more than .02 per cent points. The degree of autocorrelation of residuals still shows significant positive autocorrelation at the five per cent level, with the Durbin-Watson statistic calculated as approximately 1.35. The sign of the regression coefficients in equation number (7') shows a

TABLE 33.--Results of regressions of the Treasury bill rate on the quantity of bills in the hands of the public, and the quantity of marketable Federal debt within one year to maturity in the hands of the public, with all variables expressed (a) as first differences, and (b) as natural logarithms: January, 1953-October, 1964

(Equation number) Regression coefficients and (standard errors)	R^2	d'	r'
first differences ($\dot{x}$)			
(6') $\dot{r}_b = .0073 + \underset{(.0129)}{.0210}\,\dot{q}_b$	.02	1.34	.33
(7') $\dot{r}_b = .0074 + \underset{(.0130)}{.0231}\,\dot{q}_b + \underset{(.0068)}{.0094}\,\dot{q}_1$	.03	1.37	.32
natural logarithms ($\log_e x$ expressed as x^*)			
(8') $r_b^* = -1.9675 + \underset{(.0742)}{.8418}\,q_b^*$	.48		
(9') $r_b^* = -.5869 + \underset{(.0762)}{.7631}\,q_b^* - \underset{(.1148)}{.3585}\,q_1^*$	.51		

positive relationship between the bill rate and the quantity of non-bill marketable debt within one year of maturity, but the coefficient is small relative to the calculated standard error. The coefficients of determination are .02 and .03 respectively in equations (6') and (7'). Equations (8') and (9') indicate that the logarithmic relationships yield about the same results as equations (1') and (2').[241]

[241] Attempts to use logarithmic first-differences was complicated by the extremely small values of changes in the bill rate, as well as negative values.

An attempt was made to correlate, on a quarterly basis, the level of the bill rate with the level of the quantity of bills in the hands of the public and dummy variables to measure quarterly seasonality. The results were not very different from the monthly estimates above. The simple relationship of the end of quarter values (March, June, September, and December) of the bill rate on the quantity of bills was estimated as:

$$(10') \quad r_b = .8804 + \underset{(.0097)}{.0561}\, q_b$$

with a coefficient of determination of .43, and a <u>d'</u> of .48. With dummy variables for the second, third and fourth quarters, the equation estimated as:

$$(11') \quad r_b = .7596 + \underset{(.0098)}{.0552}\, q_b + \underset{(.2758)}{.0271}\, II + \underset{(.2754)}{.2715}\, III + \underset{(.2817)}{.2010}\, IV$$

with a coefficient of multiple determination of .45 and a <u>d'</u> of .41. The constant and the coefficients of the dummy variables provide an estimate of the average additive quarterly seasonal factor. The results of equation (11') indicate the first quarter as the low with the constant of .7596. The average amount of addition to the constant for the second quarter would be the value of the coefficient .0271. The constant plus the coefficient is .7867. For the third and fourth quarter respectively, the constant plus the coefficient yields 1.0311 and 1.0606. Nevertheless, the use of quarterly values and seasonal dummy variables helps little in the elimination of the positive autocorrelation of residuals.

In addition to the independent variables being highly autocorrelated, the equations estimated thus far indicate that all relevant variables are not being included. In order to gain further information about the relationship of the bill rate and the quantity of bills, Federal Reserve System holdings (S), and System holdings lagged one month (S_{t-1}) are utilized as independent variables. This necessitates changing the quantity of bills in the hands of the public (q_b), to the quantity issued by the Treasury less Federal Agency and trust fund holdings of bills (Q_b). The quantity of Federal marketable debt (excluding bills) with less than one year to maturity in the hands of the public (q_1) is retained as an independent variable.

The results of the regressions of the bill rate on the quantity of bills issued by the Treasury less agency holdings (Q_b), System holdings (S), and System holdings lagged one month (S_{t-1}), and the quantity of other short-term marketable debt (q_1) are summarized in Table 34. Equation (12') differs little from equation (1'). Equation (13') yields a negative sign for the regression coefficient for System bill holdings, which is the expected sign. An increase in System holdings of bills reduces the stock of bills in the hands of the public, and according to the argument illustrated in Chart 14, reduces the bill rate. From these estimates it appears that a one billion dollar change in System holdings (with Q_b held constant) has a greater effect on the bill rate than a one billion dollar change in the quantity of bills (with S held constant).

In equation (14') when System holdings in the current period and System holdings in the last monthly period are both included, the regression coefficient for S̲ is greatly reduced from the estimate in equation (13'). The matrix of simple correlation coefficients indicates the relationship of System holdings in the current period with System holdings lagged one month are positively correlated with a correlation coefficient of +.924. The reduction in the value of the regression coefficient for S̲ between equation (13') and (14') may be due to the high degree of multicollinearity between the current and lagged value of System holdings, but it could also

TABLE 34.--Results of regressions of the Treasury bill rate on combinations of: the quantity of bills issued by the Treasury less agency and trust fund holdings (Q_b), Federal Reserve System holdings of bills (S), System holdings lagged one month (S_{t-1}), and the quantity of Federal marketable debt within one year to maturity in the hands of the public (q_1)--January, 1953-October, 1964

Equation (number) and constant	Regression coefficients and (standard errors)				R^2	σ^2_u	d'	r'
	Q_b	S	S_{t-1}	q_1				
(12') .8916	.0505 (.0049)				.43	.92	.12	.94
(13') .6092	.0868 (.0072)	-.4263 (.0668)			.56	.82	.28	.86
(14') .5881	.0905 (.0072)	-.2582 (.1085)	-.2167 (.1108)		.57	.81	.24	.86
(15') 1.3778	.0823 (.0077)	-.2337 (.1061)	-.1943 (.1083)	-.0269 (.0094)	.60	.79	.28	.86

Matrix of simple correlation coefficients

	r_b	Q_b	S	S_{t-1}	q_1
r_b	1.000				
Q_b	.656	1.000			
S	.304	.796	1.000		
S_{t-1}	.306	.793	.924	1.000	
q_1	-.439	-.326	-.133	-.133	1.000

be due to the lagged effect of changes in System holdings on bank reserves, and the resulting change in the demand for bills by banks. Positive autocorrelation of the residuals is still a problem in these estimates, and the value of r' indicates that correlations between successive monthly differences is warranted. In equation (15') the sign of the regression coefficient for the quantity of non-bill debt within one year to maturity is negative--opposite to the expected sign.

In Table 35, monthly changes in the bill rate are regressed on monthly changes in: the quantity of bills issued by the Treasury (less agency and trust fund holdings), System bill holdings in the current period, System bill holdings lagged one month, and the quantity of marketable debt (excluding bills) in the hands of the public. Generally, the results indicate that positive autocorrelation of the residuals still exists, the coefficients of determination are very low, and (except for one instance) the sign of the regression coefficients for System holdings are opposite the expected sign. The high degree of relationship between the current and the lagged value of System holdings of bills shown above is not apparent using first-differences. The value of the regression coefficient for the quantity of bills (Q_b) varies between .023 and .025 per cent, essentially the same as those calculated in Table 33 for the quantity of bills in the hands of the public (q_b).

Due to the strong relationship between System holdings in the current period and System holdings lagged one month, a new series of regression equations were estimated using free reserves (R) as an independent variable instead of lagged System holdings. The results of these calculations are shown in equations (19') and (20') in Table 36. The regression coefficients for the free reserve variables indicates that a one billion

TABLE 35.--Results of regressions of monthly changes in the Treasury bill rate on changes in: the quantity of bills issued by the Treasury less agency and trust fund holdings ($\dot{Q}_b$), Federal Reserve System holdings of bills ($\dot{S}$), System holdings lagged one month ($\dot{S}_{t-1}$), and the quantity of Federal marketable debt within one year to maturity in the hands of the public ($\dot{q}_1$)--January, 1953-October, 1964

Equation (number) and constant	Regression coefficients and (standard errors)				R^2	σ_u^2	d'	r'
	$\dot{Q}_b$	$\dot{S}$	$\dot{S}_{t-1}$	$\dot{q}_1$				
(16') .0061	.0229 (.0134)	.0020 (.0454)			.02	.32	1.33	.34
(17') .0058	.0231 (.0134)	.0032 (.0412)	.0074 (.0408)		.02	.32	1.33	.34
(18') .0064	.0246 (.0134)	-.0042 (.0414)	.0008 (.0496)	..0097 (.0069)	.04	.32	1.36	.32

Matrix of simple correlation coefficients

	$\dot{r}_b$	$\dot{Q}_b$	$\dot{S}$	$\dot{S}_{t-1}$	$\dot{q}_1$
$\dot{r}_b$	1.000				
$\dot{Q}_b$	.145	1.000			
$\dot{S}$	.017	.087	1.000		
$\dot{S}_{t-1}$	.003	-.081	-.160	1.000	
$\dot{q}_1$	.107	-.081	.103	.101	1.000

TABLE 36.--Results of regressions of the Treasury bill rate on combinations of: the quantity of bills issued by the Treasury less agency and trust fund holdings (Q_b), Federal Reserve System holdings (S), free reserves (R), and the quantity of marketable Federal debt within one year to maturity in the hands of the public (q_1)--January, 1953-October, 1964

Equation (number) and constant	Regression coefficients and (standard errors)				R^2	σ_u^2	d'	r'
	Q_b	S	R	q_1				
(19') .7232	.0665 (.0047)	-.0979 (.0450)	-1.3611 (.0861)		.84	.24	.53	.71
(20') .2236	.0698 (.0045)	-.0967 (.0440)	-1.4781 (.0945)	.0174 (.0064)	.85	.23	.57	.68

Matrix of simple correlation coefficients

	r_b	Q_b	S	R	q_1
r_b	1.000				
Q_b	.656	1.000			
S	.304	.796	1.000		
R	-.523	.163	.405	1.000	
q_1	-.439	-.326	-.133	.410	1.000

dollar change in free reserves (holding the other variables in the equations constant) will cause approximately a 1.4 per cent point change in the bill rate. The relationship between free reserves and the bill rate is inverse, as expected. The partial regression coefficients of the bill quantity are approximately .07, while the partial coefficients for System holdings are slightly larger in value -.10; both sets of coefficients have the expected sign. The values of these sets of partial regression coefficients seem reasonable, both on an absolute basis and relative to each other. The sign of the partial regression coefficient for less than one-year marketable debt is the expected one, positive. However, positive autocorrelation of the residuals again is significant at the five per cent level.

Table 37 shows the results of the regressions of the first-differences of the same variables of Table 36. The partial regression coefficient of changes in the quantity of bills issued by the Treasury (less agency and trust fund holdings) is approximately the same as calculated in the two previous instances of correlations of first-differences; approximately .025 per cent points. The sign of the regression coefficient for changes in System holdings is negative, as expected, but relatively small. The sign of the coefficient for free reserves is negative, as expected, and the sign of the coefficient for the quantity of non-bill, short-term marketable debt is positive, as expected. The Durbin-Watson statistic of 1.61 in equation (22') indicates significant positive autocorrelation of the residuals at the five per cent level of significance since the required value of the statistic in this case is 1.78. The coefficient of multiple determination is only .16 approximately. However, relative to the .03 of the earlier first-difference estimates, this result is rather encouraging.

The general conclusions from the regression results presented this far indicate that: (1) there is a positive relationship between the bill rate and the quantity of bills; (2) a positive relationship exists between the bill rate and the quantity of non-bill marketable debt within one year to maturity; (3) a negative relationship is apparent between the bill rate and the average maturity of the marketable debt; (4) the expected negative

TABLE 37.--Results of regressions of monthly changes in the Treasury bill rate on changes in: the quantity of bills issued by the Treasury less agency and trust fund holdings ($\dot{Q}_b$), Federal Reserve System holdings of bills ($\dot{S}$), free reserves ($\dot{R}$), and the quantity of Federal marketable debt within one year to maturity in the hands of the public ($\dot{q}_1$)--January, 1953-October, 1964

Equation (number) and constant	Regression coefficients and (standard errors) $\dot{Q}_b$	$\dot{S}$	$\dot{R}$	$\dot{q}_1$	R^2	σ_u^2	d'	r'
(21') .0091	.0225 (.0125)	-.0006 (.0379)	-.5389 (.1102)		.15	.30	1.54	.23
(22') .0097	.0248 (.0124)	-.0093 (.0378)	-.5656 (.1186)	.0130 (.0064)	.17	.29	1.61	.19

Matrix of simple correlation coefficients

	$\dot{r}_b$	$\dot{Q}_b$	$\dot{S}$	$\dot{R}$	$\dot{q}_1$
$\dot{r}_b$	1.000				
$\dot{Q}_b$	.145	1.000			
$\dot{S}$	.017	.087	1.000		
$\dot{R}$	-.357	-.008	-.016	1.000	
$\dot{q}_1$	.107	-.081	.102	.108	1.000

relationship between the bill rate and Federal Reserve System holdings is indicated in most cases, but the magnitude is less than expected and probably not statistically significant; and (R) the free reserves variable is of great importance in explaining bill rate movements.

The partial regression coefficients of the bill rate on the quantity of bills (Q_b or q_b) have ranged from as low as .02 in the first difference equations to as high as .09 using levels of variables. These results compare favorably in sign and magnitude with the results of Okun, Turvey, and Scott. Okun, using the quantity of within-five-year marketable Federal debt in the hands of the public, obtained partial regression coefficients between the bill rate and the quantity variable ranging from .02 to .06 in various equations. Turvey, using deflated values of total Federal obligations outstanding as the independent variable and a weighted average of Federal securities rates as the dependent variable, obtained partial regression coefficients ranging roughly between .015 and .032. Finally Scott's equations, using the bill rate as the dependent variable and total Federal debt held by the public as the independent variable, estimated partial regression coefficients as .018 and .031 in separate equations. Changes in the quantity of bills in the hands of the public, holding other things constant, definitely affects the bill rate, but it appears that the demand schedule is highly elastic relative to the bill rate.

The partial regression coefficients between the bill rate and the quantity of non-bill Federal marketable debt within one year to maturity were positive in all cases where successive differences were used, and generally had a value slightly greater than .01. In equation 20' (Table 35) the partial regression coefficient was approximately .017.[242] The positive partial regression coefficient would indicate that an increase in the quantity of non-bill short-term debt would tend to increase the bill rate, but by less than an increase in the quantity of bills.

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[242]The positive partial regression coefficient is interesting in light of the negative simple regression coefficient between the bill rate and the quantity of non-bill marketable debt within one year to maturity. The simple regression coefficient between first-differences was also negative.

The partial regression coefficient between the bill rate and the average maturity of the marketable debt was negative, as expected, indicating that greater relative quantities of short-term marketable debt, while reducing the average maturity, would increase the bill rate. Additional information regarding the magnitude of this relationship will be presented below.

The partial regression coefficients between the bill rate and Federal Reserve System holdings were generally negative, but the values were smaller than expected. It was argued in Chapter VI that a Federal Reserve transaction in the open market should have a greater effect than an equal bill quantity change arising from a Treasury debt operation. The relative magnitudes in the fitted equations have shown the reverse, with the partial regression coefficients between changes in the bill rate and changes in System holdings generally near zero values. Several explanations are tenable. It may be there is just no relationship between System holdings and the bill rate, but on a priori and theoretical grounds, this is difficult to accept. A more likely explanation may lie in the timing of System transactions. Normally, the Federal Reserve Open Market Committee is pursuing both very short-run and long-run goals simultaneously. The short-run operations may lead to both bill purchases and bill sales within a single week (or day), with the net transactions actually in conflict with the long-term goal. These short-term operations may be for the purpose of correcting seasonal movements in monetary variables, which if uncorrected would lead to bill rate changes on the demand side, but due to the open market transaction the result is bill rate stability. On the other hand, if the short-run movements in the target variables are consistent with the long-run goals of the System, normal open market operations may not be carried out. On the basis of the regression equations using both System holdings and free reserves as "independent" variables, the free reserves variable was far more important in explaining bill rate movements. If the demand schedule for bills is highly elastic, which appears probable on the basis of the regression equations, the shift in the demand schedule due to a change in free reserves (which may be in part due to System transactions) has a much greater impact on the bill rate than the change in the stock of bills available to the public.

Due to the volatility in the level and changes in free reserves between country banks and non-country banks, the free reserves variable was divided into separate independent variables. In the following regressions, various combinations of the free reserves of country banks (R_c), free reserves of non-country banks (R_1), and Treasury deposits in commercial banks (T) are utilized as independent variables along with some of the previously used variables.[243] The regression equations utilizing demand deposits and time deposits as independent variables indicated that these variables, as they stand, explain practically none of the variation in the bill rate. It is believed that these variables, on theoretical grounds, are important in the explanation of the bill rate, but they must be expressed in more sophisticated fashion if the effect on the bill rate is to

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[243] In the regression results presented below, the Durbin-Watson statistic has not been calculated. It is highly probable that the degree of positive autocorrelation of residuals is significant when using levels and not significant when using successive differences. Also the time period covers two additional months (November and December, 1964) for 144 observations from January, 1953 through December, 1964.

be measured.[244] It is probable that System holdings and free reserves are actually serving to measure money supply changes.

Table 38 summarizes some selected multiple regression estimates which include combinations of R_c, R_1, and T along with a "quantity of bills" variable (Q_b or q_b). The average maturity of the marketable Federal debt is included in equations 23' through 26'. System holdings are included in equations 27' and 28'. The odd numbered equations in Table 38 measure relationships among levels of variables, and the even numbered equations measure first-difference relationships.

The partial regression coefficients for R_c and R_1 are large, with the partial coefficient for R_c being larger. The standard errors of the regression coefficients indicate a very high level of significance for R_1, with the standard errors for the coefficients for R_c being relatively larger.

In equations 23' through 26' the partial regression coefficients for the average maturity ($\overline{m}$) is negative and of the magnitude .03, both in the regressions using levels and differences. This is about one-half the values estimated in equations 3' and 4' (Table 32). The partial regression coefficients also indicate that this variable is statistically significant.

In equations 24' and 26' (using successive differences) the quantity of bills (q_b) have regression coefficients slightly smaller than the calculated standard error. The constants in the four equations using first differences are very near the mean monthly change in the bill rate which was calculated as .013. In this case, the constant is a good measure of the trend in the level of the bill rate.

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[244] For an example of various measures of "money," see: Okun, Monetary Policy, Debt Management and Interest Rates: A Quantitative Appraisal," <u>op</u>. <u>cit</u>.

TABLE 38.--Regression results of the bill rate (r_b) on various combinations of the quantity of bills (q_b and Q_b), the quantity of non-bill marketable debt within one year of maturity (q_1), the average maturity of the marketable debt ($\bar{m}$), Federal Reserve System holdings of bills (S), free reserves of country banks (R_c), free reserves of non-country banks (R_1), and Treasury deposits at commercial banks (T); with variables as levels and as successive differences: January, 1953-December, 1964

Equation number	Equation and (standard error)	R^2
(23')	$r_b = 2.924 + \underset{(.003)}{.055q_b} - \underset{(.006)}{.029\bar{m}} - \underset{(.129)}{1.202R_1} - \underset{(.335)}{1.762R}$	.87
(24')	$\dot{r}_b = .014 + \underset{(.012)}{.011\dot{q}_b} - \underset{(.011)}{.034\dot{\bar{m}}} - \underset{(.133)}{.577\dot{R}_1} - \underset{(.332)}{.482\dot{R}_c}$	.20
(25')	$r_b = 2.212 + \underset{(.004)}{.067q_b} - \underset{(.007)}{.031\bar{m}} - \underset{(.100)}{1.641R_1} - \underset{(.027)}{.059T}$	.85
(26')	$\dot{r}_b = .015 + \underset{(.012)}{.010\dot{q}_b} - \underset{(.011)}{.032\dot{\bar{m}}} - \underset{(.133)}{.639\dot{R}_1} - \underset{(.017)}{.023\dot{T}}$	.19
(27')	$r_b = 1.102 + \underset{(.004)}{.063Q_b} - \underset{(.145)}{1.150R_1} - \underset{(.358)}{1.969R_c} - \underset{(.041)}{.092S}$	.85
(28')	$\dot{r}_b = .011 + \underset{(.012)}{.023\dot{Q}_b} - \underset{(.137)}{.566\dot{R}_1} - \underset{(.340)}{.347\dot{R}_c} + \underset{(.038)}{.026\dot{T}}$	.15
(29')	$r_b = 1.440 + \underset{(.005)}{.060Q_b} - \underset{(.145)}{1.175R_1} - \underset{(.358)}{2.006R_c} - \underset{(.041)}{.090T}$	.86
(30')	$\dot{r}_b = .012 + \underset{(.012)}{.023\dot{Q}_b} - \underset{(.137)}{.598\dot{R}_1} - \underset{(.337)}{.405\dot{R}_c} - \underset{(.017)}{.026\dot{T}}$	.16

In equations 25', 26', 29', and 30', the partial regression coefficients for Treasury deposits are negative, as expected. An increase in Treasury deposits at commercial banks is associated with bill rate decreases. This reflects increased free reserves (the simple correlation coefficient indicates a much higher association with R_1 than with R_c), and an increase in the quantity of bills sold by the Treasury could lead to increases in T causing this variable to measure the same phenomena as Q_b: the partial regression coefficient for T ($\dot{T}$) is nearly the same magnitude as the coefficient for Q_b ($\dot{Q}_b$). Federal Reserve open market transactions may be undertaken to adjust for fluctuations in monetary variables caused by fluctuations in Treasury deposits. The partial coefficients in equations 27' and 28' show mixed signs between the equation using levels of variables and the equation using successive differences. The partial regression coefficient of S in equation 27' is slightly larger than the partial coefficient for the quantity of bills as hypothesized, but on the basis of the past estimates of this coefficient, little confidence can be attached to the magnitude.

An additional equation was estimated using seven independent variables including time. The partial coefficients of determination are included in parentheses above the appropriate partial regression coefficient, and the standard errors in parentheses below the regression coefficient. The equation was calculated as:

$$(31') \quad r_b = 2.349 + \underset{(.009)}{\overset{(.141)}{.043q_b}} + \underset{(.007)}{\overset{(.023)}{.013q_1}} - \underset{(.007)}{\overset{(.058)}{.020\bar{\bar{m}}}} - \underset{(.145)}{\overset{(.387)}{1.340R_1}}$$

$$- \underset{(.348)}{\overset{(.153)}{1.727R_c}} - \underset{(.025)}{\overset{(.060)}{.074T}} + \underset{(.003)}{\overset{(.036)}{.006t}} \qquad R^2 = .88$$

Although $\bar{\bar{m}}$ is related to q_b and q_1, while T is related to R_1 and R_c, the result is interesting. The partial coefficient for q_b (+.043) is between the partial coefficients of levels and successive differences measured up to this point. Very subjectively, this seems a reasonable estimate for the partial regression coefficient for q_b. The other regression coefficients seem reasonable in their magnitudes and are all of the sign expected from the simple theoretical model. The partial coefficients of determination, although probably biased upward because of autocorrelation of the residuals, indicate that R_l and R_c ("demand" variables) are the most important variables in this equation, with q_b third most important. Although the remaining partial coefficients of determination are relatively small, all of the partial regression coefficients are more than 1.8 times as large as their standard errors.

In order to obtain some measure of the seasonality in the bill rate movements, equations utilizing "supply" variables along with dummy variables for each month were estimated. Utilizing dummy variables for each month allows the estimation of the seasonality of the dependent variable as an additive factor. Actually a separate intercept is calculated for each month.[245] The dummy seasonal variables are indicated by Roman numerals (i--January, ii-February, etc.). Standard errors of these coefficients are omitted, and instead the relative ranks, from one to twelve, are indicated below the coefficient and underlined. Equation 20' (Table 36) was re-estimated with the inclusion of dummy seasonal variables, with the result:[246]

---

[245] Lovell, _op_. _cit_., and Johnson, _op_. _cit_. In these regressions the dummy variables are _0_ and _1_. There are eleven dummy variables, all having the value of zero for January, all having zero values for February except the first which would have the value _1_--and in December the last dummy would be _1_, and all others would have zero values.

[246] From this point on in the estimation of empirical equations, the relevant time span is from January, 1953 through December, 1964; twelve years, 144 observations.

$$
(32') \quad r_b = \underset{(.0045)}{.0751Q_b} - \underset{(.0432)}{.1751S} - \underset{(.0896)}{1.400R} + \underset{(.0061)}{.0126q_1} + \underset{\underline{5}}{.3640i} + \underset{\underline{12}}{.0872ii}
$$

$$
+ \underset{\underline{9}}{.1471iii} + \underset{\underline{10}}{.1434iv} + \underset{\underline{11}}{.1314v} + \underset{\underline{6}}{.3635vi} + \underset{\underline{7}}{.3211vii} + \underset{\underline{8}}{.3042viii}
$$

$$
+ \underset{\underline{2}}{.4922ix} + \underset{\underline{4}}{.4314x} + \underset{\underline{3}}{.4520xi} + \underset{\underline{1}}{.6081xii} \quad (R^2 = .882 \quad d' = .549)
$$

The coefficient of multiple determination was slightly higher than for equation 20', but the Durbin-Watson statistic was only slightly changed (the required value for a rejection of the null hypothesis at the 5 per cent level is 1.65). The seasonal regression coefficients compare favorably in their ranking above and below "normal" with the seasonal factors calculated in Chapter III. The most interesting difference between equation 20' and equation (32') is the increase in the magnitude of the regression coefficient for System holdings (from -.0967 to -.1751).

To this point in the calculation of regression equations the quantity of non-bill marketable debt within one year to maturity. In order to gain some insight as to whether a single quantity variable, combining Q_b and q_1, might give better results, equation 33' was estimated after summing Q_b and q_1 to form the variable "quantity of Federal marketable debt within one-year of maturity" (q), including Federal Reserve System bill holdings (S), which is considered as a separate variable. The estimation of such an equation yielded:

$$
(33') \quad r_b = \underset{(.0051)}{.0557q} + \underset{(.0442)}{.0676S} - \underset{(.0969)}{1.850R} - \underset{\underline{1}}{.3754i} - \underset{\underline{9}}{.5800ii} - \underset{\underline{8}}{.5657iii}
$$

$$
- \underset{\underline{10}}{.5874iv} - \underset{\underline{12}}{.6797v} - \underset{\underline{5}}{.5132vi} - \underset{\underline{7}}{.5458vii} - \underset{\underline{11}}{.6193viii} - \underset{\underline{2}}{.3665ix}
$$

$$
- \underset{\underline{4}}{.4462x} - \underset{\underline{6}}{.5243xi} - \underset{\underline{3}}{.3879xii} \quad (R^2 = .804 \quad d' = .508)
$$

The regression coefficient for the quantity variable (.0557) appears reasonable enough, and the standard error of the regression coefficient, in absolute terms is only slightly larger than the error for q_b in equation 32'. The coefficient of multiple determination is comparable, but the Durbin-Watson statistic indicates a very high probability of positively autocorrelated residuals. However, the regression coefficient for System holdings is positive instead of negative which is opposite the expected sign. When the results of equation 33' are compared with the results of equations utilizing q_b and q_1 as separate independent variables measuring the quantity of marketable non-bill Federal debt within one year of maturity as a good, although imperfect, substitute for Treasury bills is tenable and helpful. Possibly other independent variables measuring the quantity of marketable Federal debt in longer maturity categories would be desirable. However, the only additional debt variable used is the average time to maturity of the marketable debt.

Equation 31', excluding the time trend variable (t), was re-estimated using dummy variables to measure seasonality. The estimated equation was:

$$(34') \quad r_b = \underset{(.0036)}{.0749q_b} + \underset{(.0008)}{.0161q_1} - \underset{(.0063)}{.0203\overline{m}} - \underset{(.0939)}{1.5612R_1} - \underset{(.0353)}{.6225R_c}$$

$$- \underset{(.0319)}{.1463T} + \underset{\underline{10}}{1.4315i} + \underset{\underline{12}}{1.332ii} + \underset{\underline{9}}{1.477iii} + \underset{\underline{11}}{1.402iv}$$

$$+ \underset{\underline{8}}{1.598v} + \underset{\underline{4}}{1.736vi} + \underset{\underline{6}}{1.673vii} + \underset{\underline{5}}{1.683viii} + \underset{\underline{1}}{1.820ix}$$

$$+ \underset{\underline{2}}{1.753x} + \underset{\underline{7}}{1.671xi} + \underset{\underline{3}}{1.750xii} \quad (R^2 = .898 \quad d' = .674)$$

The coefficient of multiple determination is virtually unchanged from that of equation 31', and the Durbin-Watson statistic leads again to a rejection of the null hypothesis of independently distributed residuals. The regression coefficients for q_b and T are increased when the dummy seasonal variables are included, but the most surprising result is the change in the regression coefficient for R_c; from -1.727 in equation 31' to -.623 in equation 34'. Although the regression coefficient has been changed drastically, the standard error in equation 34' is smaller relative to the coefficient than in equation 31'.

Since the time variable was eliminated in equation 34', it was felt that this may have affected the partial regression coefficient for R_c, but recalculations of equation 31' excluding the time variable changed the partial coefficient from -1.727 to -1.885. Another possible explanation is provided by Lovell in a reference to the appropriateness of utilizing dummy seasonals with seasonally unadjusted variables. He comments that:

> Although both the dependent and independent variables may be subject to considerable seasonal movement, it is possible that the seasonality in the dependent variable is entirely the consequence of seasonal influences acting directly through the explanatory variables.[247]

If the independent variables in this equation "explain" the seasonality in the bill rate, then the dummy seasonal variables are redundant. The reason why the relationship between the bill rate and country bank free reserves "washes out," while the other relationships remain relatively constant, is not easy to explain. The bill rate--country bank free reserves relationship of equation 31' (and other equations) may have been supurious. But conversely, the seasonal variations in country bank reserves could have been the most important factor in "explaining" the seasonality of the bill rate, and when the dummy seasonal variables were included the relationship vanished.

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[247] Lovell, *op. cit.*, p. 1005.

In this particular case the dummy seasonal variables may do more harm than good, although in equation 32' above and equation 35' below, relationships between the bill rate and System holdings of bills, which may have been obscured without utilizing dummy seasonal variables, possibly become more apparent when seasonal proxies are used. The conclusions are highly conjectural, but the problem indicates that since we are attempting to explain short-term bill rate movements, with appropriate independent variables, the use of dummy seasonal variables may not always be justified.

Another equation of this type is shown below, and is a re-estimation of equation 22' with dummy seasonal variables included. The proxy variables in the successive differences situation do not measure seasonality relative to any "normal" month, but instead measure the average change between successive months. For example, in the preceding equations using dummy seasonal variables, December usually had the greatest addition (smallest subtraction) whereas in this situation the November bill rate is higher than "normal," therefore the December adjustment will be relatively smaller than when levels are used, indicating greater <u>change</u> between October and November than between November and December. The re-estimation of equation 22', adding the dummy seasonal variables, yielded:

$$(35') \quad \dot{r}_b = \underset{(.0158)}{.0356\dot{q}_b} - \underset{(.0460)}{.0458\dot{S}} - \underset{(.1178)}{.5686\dot{R}} + \underset{(.0063)}{.0113\dot{q}_1} - \underset{\underline{11}}{.0892i} - \underset{\underline{12}}{.176ii}$$

$$- \underset{\underline{7}}{.006iii} + \underset{\underline{5}}{.018iv} - \underset{\underline{10}}{.051v} + \underset{\underline{4}}{.072vi} - \underset{\underline{8}}{.024vii} + \underset{\underline{3}}{.094viii}$$

$$+ \underset{\underline{1}}{.181ix} - \underset{\underline{9}}{.041x} + \underset{\underline{6}}{.015xi} + \underset{\underline{2}}{.121xii} \quad (R^2 = .336 \quad d' = 1.652)$$

The regression for $\dot{q}_d$ in equation 35' (.0356) is higher than in equation 22' (.0248); and the regression coefficients for $\dot{R}$ and $\dot{q}_1$ are nearly the same in the two equations. The regression coefficient for $\dot{S}$ in equation 35' (-.0458) is much larger than the corresponding coefficient in equation 22'; and in addition, the coefficient for $\dot{S}$ in equation 35' is larger than the regression coefficient for $\dot{q}_b$, as hypothesized. However, the regression coefficient for $\dot{S}$ is about the same size as the standard error, and the coefficient is not statistically significant. Nevertheless, it appears that if factors contributing to seasonality are "held constant," the influence of System bill holdings on the bill rate through changes in the stock of bills becomes more apparent. If System open market operations were taking place to absorb seasonal movements in bank reserves, the effect of the transactions may prevent bill rate movements that would have occurred in the absence of System action.

The coefficient of multiple determination is approximately .34, double the value of equation 22'; but still indicative that the influence of major explanatory variables is not included. The Durbin-Watson statistic of 1.65 indicates that biases from autocorrelation of residuals still exist since the Durbin-Watson statistic required for this many variables and observations is 1.96 at the five per cent significance level.[248]

Positive Autocorrelation of Residuals

Throughout this Chapter the empirical equations have shown biases arising from positive autocorrelation of the residuals, in some cases even when variables were expressed as successive differences. In an attempt to eliminate the positive autocorrelation biases, the ρ transformation, discussed in Chapter V, was applied to two equations previously estimated in this Chapter--equations 20' and 32'.

In equation 20' the estimated autocorrelation coefficient (ρ) was .72, and the equation estimated using the dependent variable and the independent variables transformed ($X_{i_{t-1}}' - \rho X_{i_{t-1}}$) was:

$$(36') \quad r_b = .0549 + \underset{(.0064)}{.0560Q_b} - \underset{(.0394)}{.0391S} - \underset{(.1151)}{.9578R} + \underset{(.0068)}{.0096q_1}$$

$$(R^2 = .54 \qquad d' = 1.57)$$

The value of d' to reject the null hypothesis of positive autocorrelation of residuals at the five per cent level of significance is, for this problem, 1.78. Comparing the regression coefficients of equation 36' and the coefficients of 20' and 22' indicates generally that the coefficients in equation 36' are larger than those in equation 22' but smaller than those of 20'. Even though it appears that positive autocorrelation of the residuals is still present, the values of the coefficients of 36', absolutely and relative to their standard errors, are preferable to those of 20' and 22'. The Durbin-Watson statistic of 1.61 for equation 22' is only slightly above the value of the statistic of equation 36'. There is a possibility also that the first-order autocorrelation assumption should be replaced by a second-order assumption.

In equation 32' the estimated autocorrelation coefficient was .73, and the equation estimated using the resulting transformed variables was:

$$(37') \quad r_b = \underset{(.0069)}{.0624Q_b} - \underset{(.0468)}{.0996S} - \underset{(.1126)}{.9956R} + \underset{(.0065)}{.0090q_1} + \underset{\underline{9}}{.0495i} - \underset{\underline{12}}{.0144ii}$$

$$+ \underset{\underline{6}}{.0554iii} + \underset{\underline{8}}{.0504iv} + \underset{\underline{11}}{.0401v} + \underset{\underline{3}}{.0903vi} + \underset{\underline{10}}{.0472vii} + \underset{\underline{5}}{.0658viii}$$

$$+ \underset{\underline{1}}{.1073ix} + \underset{\underline{7}}{.0548x} + \underset{\underline{4}}{.0693xi} + \underset{\underline{2}}{.1039xii} \quad (R^2 = .63 \qquad d' = 1.64)$$

Again the Durbin-Watson statistic (1.64) is lower than that required (1.96), and autocorrelation of the residuals has not been eliminated.

However the Durbin-Watson statistic for these variables when first differences were used (equation 35') was only 1.65. In equation 37' the regression coefficient for System holdings (-.0996) is larger ignoring the sign) than for the coefficient for the quantity of bills (.0624); and is more than twice its standard error. Expect for the regression coefficient for System holdings, the values of the other regression coefficients are extremely near their respective values in equation 36'. The signs and the values of the regression coefficients appear quite satisfactory relative to the previous estimates and discussion in this Chapter.

In a final attempt to eliminate positive autocorrelation of the residuals, an equation was calculated including the bill rate lagged one month (r_{b-1}) as an independent variable. Taking again the variables used in equation 20', and adding the lagged bill rate as an independent variable, an equation was estimated as:

$$(38') \quad r_b = .1501 + \underset{(.0042)}{.0149Q_b} + \underset{(.0239)}{.0232S} - \underset{(.0824)}{.5117R} + \underset{(.0038)}{.0030q_1} + \underset{(.0453)}{.7285r_{b-1}}$$

$$(R^2 = .95 \qquad d' = 1.28)$$

Although the Durbin-Watson statistic is much higher in equation 38' than in equation 20', positive autocorrelation of the residuals still exists. The regression coefficients for S and q_1 are not statistically significant. The only purpose of this attempt was to eliminate positive autocorrelation, and an economic interpretation of equation 38' is difficult. A possible rationale for including the lagged bill rate as an independent variable might be sought in viewing bill holders as expecting the current rate to equal the rate existing last month.

Another equation was estimated including dummy variables and the results were similar. The multiple coefficient of determination was .96, but the Durbin-Watson statistic was less than for equation 38', having a value of 1.20. In this additional equation the sign of System holdings was negative as expected, differing from the sign of the coefficient in equation 38', but still statistically insignificant.

An additional observation on these final estimates refers to the decrease in the value of the Durbin-Watson statistic as dummy seasonal variables were added. It seems possible that the changing seasonal pattern over the time period could cause the dummy seasonal variables, whose coefficients indicate additive seasonality and are simply an average for the period, could add to the problem of positive autocorrelation instead of reducing it.

Summary and Conclusions

Very generally, it has been shown that the quantity of bills, and the quantity of bill substitutes, affect the level of the Treasury bill rate, with increases in quantity being related to increases in the rate. The evidence is not so clear-cut for Federal Reserve System open market operations, but the relationship between System bill holdings and the bill rate seems generally to be inverse, as hypothesized on the basis of Chart 14, Chapter VI. The average time to maturity of the Federal marketable debt also is inversely related to the bill rate, as was expected.

Several multiple regression equations were calculated to different time periods, and several equations of successive differences of variables were estimated excluding periods of extreme fluctuations in the bill rate. The results of these attempts were not different, in important respects, to the equations presented above.

The use of free reserves (R, R_1, and R_c) appeared to be helpful in obtaining estimates of the effects of debt quantity variables on the bill rate. Also, it became apparent through using these variables that shifts in the demand schedule seem more important in the determination of the bill rate than changes in the quantity of bills.

In the statistical sense, the equations above are not as adequate as had been desired. Using levels of variables results in positive autocorrelation of the residuals; and the use of successive differences, although reducing the degree of bias from positive autocorrelation of residuals, explained a small proportion of the variance in bill rate changes. Transformation of variables by the coefficient of autocorrelation provides estimates which bridge the gap between high degrees of autocorrelation of residuals using levels and low coefficients of multiple determination when using successive differences.

As expected, the coefficients of multiple determination in the transformed variable estimates are smaller than when levels of variables are used.

A relevant consideration in the relationship between the bill rate and the quantity of bills is the degree of independence of the quantity of bills issued by the Treasury. If the Treasury does a considerable amount of "tailoring" in its issue of bills, the quantity of bills available is partially determined by the requirements of holders. Tax-anticipation bills provide an example of bill issues which partially satisfy increased demand for short-term debt by non-financial corporations and banks. However, the use of tax-anticipation bills is useful to the Treasury in equalizing volatile cash receipts and in the refinancing of existing debt. The net result of "tailoring" by the Treasury would be a reduction in bill rate seasonality arising from seasonality in demand.

Variations in the demand for bills appears to have relatively a greater effect on the bill rate than variations in the bill stock. The variables included in the regression equations of this Chapter simply do not explain, to a satisfactory degree, movements in the bill rate. In Chapter VIII the demand for Treasury bills by various institutional sectors and the effect on the bill rate are discussed.

CHAPTER VIII

RELATIONSHIPS BETWEEN THE BILL RATE AND BILL HOLDINGS OF INSTITUTIONAL SECTORS

Introduction

In this portion of the analysis the relationships between the bill rate and bill holdings of selected institutional sectors are investigated. The institutional sectors discussed are: commercial banks, foreign governments and banks, non-financial corporations, state and local governments, and dealers in Government securities. Mutual savings banks, insurance companies, and retirement and trust funds, although important holders of marketable Federal debt, are excluded from discussion because of their concentration of holdings in long-term debt and relatively small holdings of bills.

According to the model presented in Chapter V, the stock of bills available to the public is determined by Treasury and Federal Reserve System debt management decisions. Thus the equilibrium bill rate is determined by the willingness of the public to hold the available stock. If an institutional sector desires to reduce its net holdings of bills, either other sectors in the market must be willing to add bills to their portfolios at the current bill rate or the bill rate will increase--reflecting a shift in the reserve demand schedule to the left.

The stock of bills, however, has not remained constant over the period; rather it has increased greatly. The time series of holdings by various institutional sectors reflects the increase in the bill stock. For those sectors desirous of holding short-term Federal marketable debt, sector bill holdings have increased, at least in part, because of the increase in the quantity of bills in proportion to the total short-term Federal debt. The relationship between the bill rate and the stock of bills available is identical with the relationship between the bill rate and the total quantity of bills held by the public. Therefore, multiple regressions of the bill rate on levels of holdings of bills by various institutional sectors will assuredly contain biases due to autocorrelation of residuals. Monthly sector holdings as a per cent of the bill stock might eliminate some of these biases.

Ideally, the underlying reasons for changes in bill holdings for each sector should be explained. For instance, the theoretical framework explaining the levels of bills held by commercial banks, and other relevant sectors should be developed, and, if possible, empirically verified. This approach, however, approximates a general equilibrium analysis. The approach taken here will be that of partial equilibrium--given a change in bill holdings by certain sectors, how is the bill rate affected? It is apparent though, that given the stock of bills available to the public to hold, a change in one sector's holdings must be reflected in an opposite change in the holdings of other sectors.

Relating the bill rate to the quantity of bills held by various sectors implies that the demand of an institutional sector is relatively inelastic to the level of bill rates, or the difference between the bill rate and the rate on substitutes. The degree of sensitivity of debt holders to interest rate changes is a debatable point. An illustration of differences of opinion regarding interest elasticity of the demand for debt instruments is provided by the following quotations. Robert V. Roosa has argued that:

> ...certain institutional changes, marked by the channeling of loanable resources into highly specialized investment concerns, has made lenders acutely sensitive to slight changes in the yield differentials among alternatives, both short and long. A steadily growing popular insistence on "security"--the avoidance of loss, at the expense of accepting lesser yields--had favored the growth of conservative intermediary institutions, operating on relatively narrow margins, and alert to small changes among the yields on debt instruments that would have been considered trivial a few decades earlier.[249]

Assar Lindbeck, addressing himself directly to this argument by Roosa, has recently pointed out that it is probably true that institutional asset holders are sensitive to interest rate changes. However, the argument of "liquidity" oriented holders being sensitive to small changes in the level of rates, seems to Lindbeck:

> ...to rest on a fallacy....For, if an asset holder values, on the margin, safety and liquidity highly as compared to risk, he requires a relatively great interest rate compensation to switch from money balances and government securities to private loans, and _vice versa_. In other words, the higher the value set on safety and liquidity relative to yield, on the margin, the smaller are the effects on portfolio policy of a given change in interest rates.[250]

Applying Lindbeck's argument more narrowly to Treasury bills, it is contended that the choice of holding highly liquid Treasury bills or

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[249] Robert V. Roosa, "Interest Rates and the Central Bank," _Money, Trade and Economic Growth: Essays in Honor of John Henry Williams_ (New York: Macmillan Company, 1951), pp. 277-278.

[250] Lindbeck, _A Study in Monetary Analysis_, _op. cit._, p. 225.

other very short-term Government debt is, for a large portion of bill holders, more of a choice between bills and money than a choice between bills and other longer-term, higher-risk, higher-yielding assets. For instance, a commercial bank satisfies its secondary reserve requirements by holding excess reserves or highly marketable or quickly maturing assets, and above the minimum desired level of liquidity chooses among assets on the basis of relative yield, risk and liquidity. This surely does not mean that all bills in the economy have been acquired or maintained in portfolios without regard to relative yields on other assets, but that a sizeable portion of the total quantity of bills held by institutions are not responsive to rate changes. Deane Carson, in an article critical of the "bills only" policy of the Federal Reserve System, commented that:

> Much of the supply of bills outside the Reserve is in the hands of holders who are not sensitive to changes in the price of these instruments. To these investors (corporations and some banks, for example) bills are considered a superior alternative to holding cash, and riskless in the sense that they mature to par. The small gain which a corporation would realize through a sale prior to maturity is generally not considered worth the trouble involved. Thus, a large segment of the bill supply is frozen; in order to dislodge sufficient sales to the System, it may be necessary to bid <u>higher</u> prices than would be required otherwise.[251]

Approaching this problem from an empirical point of view, how does seasonality of the bill rate arise if asset holders are highly sensitive to small rate changes? Apparently longer-term Government securities do not exhibit nearly the degree of seasonal movements in rates as do bills, and if holders reacted to seasonal movements in bill rates, or

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[251] Deane Carson, "Recent Open Market Committee Policy and Techniques," The Quarterly Journal of Economics, Vol. LXIX, No. 3 (April, 1955), p. 340.

anticipated these recurrent movements, arbitrage should smooth out bill rate seasonality. No doubt arbitrage exists to a degree in the bill market, but the magnitude of bill transactions and bill holdings by institutions satisfying "liquidity" needs--regardless of relative rates--is evidently stronger than arbitrage activity because significant seasonality does exist in the Treasury bill rate.

According to our simple hypothesis of bill rate determination, demand changes affect the bill rate. The seasonality of the bill rate measured in Chapter III should be explained by the seasonality in the bill stock and seasonality in holdings by principal sectors.

A principal problem in measuring seasonality in bill holdings[252] is the complete lack of data in some cases and survey data for only short time periods for other cases. Only for the Federal Reserve System and member commercial banks are reliable holdings data available for the complete period.[253] Monthly holdings data for Treasury bills and Certificates of Indebtedness combined are available for the complete period for the international sector--separate bill holding data are unavailable. Non-financial corporation holdings of bills are available from a survey covering approximately 50 per cent of total non-financial corporate holdings since January, 1960. State and local government general fund holdings of bills are available from survey data which cover approximately 50 per cent

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[252] The data limitations also restricts the meaningfulness of the equations measuring the effect on the bill rate of changes in sector holdings.

[253] Bill holdings of the United States Government agencies and trust funds are available, but these values have already been substracted out in determining the quantity of bills in the hands of the public. Since these holdings are relatively small, no attempt was made to analyze them separately.

of total general fund holdings from September, 1960 to January, 1964, and approximately 70 per cent thereafter. Total holdings of Federal securities for non-financial corporations and state and local governments are available monthly for the complete period on the basis of Treasury estimates from benchmark data, but total holdings provide little help in measuring short-run changes in bill holdings. Average daily net dealer positions and average daily gross transactions in Federal marketable securities having less than one year to maturity are available on both a monthly and weekly basis in the Federal Reserve Bulletin from a Federal Reserve Bank of New York survey for the period since September, 1960. Weekly dealer data including a separate category of Treasury bills are available for the period November, 1957 through December, 1958. In addition, unpublished dealer holdings of bills have been provided by the Federal Reserve Bank of New York on a weekly basis for the period September, 1960 through December, 1961. Unfortunately the three series are not directly comparable.

Nevertheless, estimates of seasonality have been made, and the effects on the bill rate are discussed on *a priori* grounds. Because of the shortcomings in the data, no attempt has been made to estimate seasonality by any precise method. The simple ratio-to-moving-average method has been employed to derive multiplicative specific seasonal factors. For the quantity of bill series and commercial bank holdings, the factors are relatively stable. For the Federal Reserve System, and the shorter series, the seasonal factors are quite unstable and should be viewed as crude estimates. The time series of holdings of bills by the international sector exhibited no significant seasonality.

Viewing the relative magnitudes of holdings by various sectors, and the movement of the series relative to the bill rate, it appears that the commercial banking sector may be the most important factor on the demand side affecting the Treasury bill rate. In Chapter VII it was shown that free reserves were highly related to the bill rate, and it was asserted that this reflected changes in demand by commercial banks. This assertion is examined in greater detail in this part of the study.

Due to the lack of adequate bill holding information for important sectors, most of the conclusions of this Chapter will be rather tentative. In light of the conclusions of Chapter VII, that changes in demand for bills appear to be much more important than changes in the stock of bills, this is an unfortunate circumstance. It is hoped, however, that a few interesting possibilities might be encountered with the data available.

The analysis begins with the presentation of bill holding data for the most important institutional sectors: commercial banks, foreign governments and banks, non-financial corporations, state and local governments, and U. S. Government securities dealers. The determinants of the holdings of commercial banks will receive a brief analysis. For the remainder of the sectors, a brief discussion of the determinants of bill holdings and a review of some of the more relevant studies will be presented. This will be followed by a discussion of the seasonality of the bill stock and the seasonality of bill holdings by sectors. Some empirical estimates are then made relating bill rate changes to bill holdings by sectors. As in the last Chapter, dummy variables will be included for measuring seasonality.

Treasury Bill Holdings by Institutional Sectors

Commercial banks

Commercial banks hold Treasury bills and other short-term Government securities in sizeable quantities as secondard reserves--liquid assets held in excess of vault cash, deposits with correspondent banks and required reserves.[254] Short-term marketable securities satisfy the liquidity needs of commercial banks, bridging the gap between excess cash reserves and investment in longer-term securities of relatively low risk, and higher-risk, lower-yield loans. The holding of Treasury bills by commercial banks may be viewed as satisfying "transactions," "precautionary," and "speculative" motives for commercial banks. If a commercial bank begins to feel pressure on its reserve position, Treasury bills may be sold in the open market, used as eligible paper in borrowing from the Federal Reserve System, or held until maturity and redeemed for cash.

The view taken here is that the quantity of bills held by the member commercial banks is determined as a part of the complete portfolio decision, inclusive of decisions as to the proportion of assets to be held in cash, loans, or any other type of security. For commercial banks, these decisions have been characterized as "liquidity versus earnings." The Treasury bill is ideal in providing some earnings, dependent on the level of the bill rate, and liquidity needs.

It was argued in Chapter VI that Federal Reserve System transactions in the open market affected commercial bank bill holdings, and in Chapter

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[254] For a discussion of liquidity needs and secondary reserves, see: The Commercial Banking Industry. The American Bankers Association (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1962), pp. 272-280.

VII it was argued that free reserves were an indicator of the demand for bills by commercial banks. The arguments provided in the last two Chapters were inadequate, and it is necessary to examine more closely the direction and magnitude of the effect of these variables, through commercial bank holding of bills, on the bill rate. A central assumption of this discussion is provided by Meigs in the explanation of the time lag of the effect of open market operations on commercial bank free-reserve ratios.

> An interest rate explanation for lags in the response of free reserves to open market operations can be based upon the contention of this study that market interest rates are not determined by the free-reserve ratio but that they are influenced by the rates per unit of time at which the Federal Reserve System and the member banks buy and sell assets.[255]

Revising this hypotheses for the more narrow purposes of bill rate analysis, the Treasury bill rate is directly affected by changes in holdings of bills by commercial banks and the Federal Reserve System, with bank holdings affected by System open market transactions.

The Federal Reserve System through open market purchases and sales, or through changes in reserve requirements, can influence member bank reserves. The member commercial banks, however, make the final determination of the level of free reserves they desire to hold by their reaction to the attempts of the Federal Reserve System to influence their free reserve position. If the System, in a one month period, is a net buyer of bills, and commercial banks maintain the same portfolio at the end of the period as they had at the beginning of the period, free reserves increase. But commercial banks may immediately react to the changes in their reserve position by increasing their loans and investments, and at the end of the

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[255] Meigs, _op_. _cit_., p. 85.

period free reserves possibly may be less than at the beginning of the period.

The level of holdings of Treasury bills by member commercial banks at the end of each month for the period 1953 through 1964 is shown in Table 39.[256] Generally, over this period the quantity of bills held by commercial banks has shown some increase, but has fluctuated over a wide range with changes of one billion dollars or more between successive months not uncommon. The range of holdings over the period are from the low of $1.875 billion at the end of March, 1956, to a high of $10.969 billion for December, 1964. A seasonal pattern in holdings is also apparent.

Early in 1953, bill holdings of member commercial banks began a decline, leveling out at roughly three billion dollars. Holdings persisted at this level with some important fluctuations until the increase in holdings began in late 1960. Part of the increase in the level of bill holdings by commercial banks may be accounted for by the increasing percentage of the short-term marketable debt being issued by the Treasury in the form of bills. In 1960 the Treasury began to issue six-month, nine-month, and one-year bills in lieu of alternative forms of debt.

Several other relative measures of bank holdings of bills are shown in Table 40 for June 30 dates for the period 1953-1964. First, the level of member commercial bank holdings of: bills, within-one-year

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[256]Member bank holdings by approximately 6,000 banks account for roughly 90 per cent of total bank holdings of Federal marketable debt. Semiannually the Treasury presents a detailed survey of commercial bank ownership by type of security for: 6,000 commercial banks, broken down by nonmember banks and by member banks with a further breakdown of member banks into New York City, Chicago, other Reserve city and country banks. See, for instance, Section I, p. 75, Treasury Bulletin, February, 1965.

TABLE 39.--Member commercial bank holding of bills, monthly, January, 1953-December, 1964 (in billions of dollars)

Month	1953	1954	1955	1956
January	6.538	4.723	4.268	2.839
February	5.381	3.920	3.807	2.493
March	4.048	3.858	2.968	1.875
April	3.805	5.024	3.503	2.280
May	3.662	4.145	2.682	2.228
June	4.411	4.411	2.721	2.181
July	5.015	4.368	2.775	1.924
August	4.556	5.068	2.712	2.008
September	4.500	4.962	2.846	2.468
October	4.579	4.890	2.584	3.038
November	4.298	4.357	2.369	3.911
December	4.368	4.399	3.562	4.934
Month	**1957**	**1958**	**1959**	**1960**
January	4.332	3.892	4.838	4.793
February	3.939	3.999	4.815	3.796
March	2.944	3.322	3.699	2.518
April	3.200	3.817	4.504	3.150
May	3.975	3.522	4.383	2.765
June	2.853	3.796	3.563	2.376
July	3.852	3.886	4.838	4.554
August	4.985	3.261	4.499	4.344
September	3.892	3.509	4.307	5.127
October	3.880	4.496	4.545	7.080
November	3.514	5.511	3.705	6.455
December	4.332	5.194	5.011	6.976
Month	**1961**	**1962**	**1963**	**1964**
January	7.486	9.886	9.282	8.782
February	6.488	9.029	9.096	8.299
March	4.750	7.095	8.039	7.984
April	6.447	7.480	8.481	7.501
May	5.917	7.340	7.945	7.130
June	6.379	7.090	7.633	7.505
July	9.153	6.931	6.890	6.993
August	8.814	6.610	5.977	7.507
September	10.133	6.850	7.796	9.168
October	9.530	8.352	8.299	9.562
November	9.287	8.404	7.821	10.108
December	9.962	9.838	9.290	10.969

Sources: Federal Reserve Bulletin and Treasury Bulletin, various monthly issues, 1952-1965.

TABLE 40.--Commercial bank holdings of selected categories of Federal marketable debt, June 30 dates, 1953-1964 (in billions of dollars)

Year	Commercial bank holding of			Quantity of bills in the hands of the public (q_b) (4)	Quantity of Federal marketable debt within one year of maturity in the hands of the public (q) (5)
	Bills (1)	Within one year (2)	Total marketable (3)		
1953	4.411	19.580	51.365	18.146	48.921
1954	4.411	17.684	56.199	17.954	45.273
1955	2.721	7.187	55.667	18.588	32.224
1956	2.181	7.433	49.517	19.680	37.545
1957	2.853	12.268	48.590	23.003	49.619
1958	3.796	13.431	57.379	19.530	43.873
1959	3.563	10.045	53.394	29.899	51.341
1960	2.376	6.546	48.004	30.531	49.452
1961	6.379	20.153	55.033	33.082	63.287
1962	7.090	21.511	57.038	38.276	68.073
1963	7.633	15.541	55.439	42.724	61.955
1964	7.505	14.549	51.108	44.110	61.573

Sources: Various monthly issues of the Federal Reserve Bulletin and the Treasury Bulletin.

marketable Federal debt (including bills), and total marketable Federal debt are shown along with the quantity of bills in the hands of the public (q_b), and the total quantity of Federal marketable debt within one year of maturity in the hands of the public. In the second portion of the table, member bank holdings of various categories of marketable Federal debt are expressed relative to other debt and holding levels. The relative measures, shown in Table 41, include:

a. member commercial bank bill holdings as a percentage of commercial bank holdings of within one year of maturity Federal marketable debt,

TABLE 41.--Commercial bank holdings of selected Federal debt instruments expressed as ratios to holdings and debt categories, June 30 dates, 1953-1964 (ratios calculated from column numbers from Table 39)

Year	Commercial bank holdings of bills as a percentage of			Commercial bank holdings of within one year marketable Federal debt as a percentage of		Ratio of bill holdings to one year holdings as a percentage of the ratio of the quantity of bills to quantity of one year marketable
	Bank holdings of marketable debt within one year of maturity	Bank holdings of marketable Federal debt	Quantity of bills in hands of public	Bank holdings of marketable Federal debt	Total marketable debt due within one year	
	(1/2)	(1/3)	(1/4)	(2/3)	(2/5)	(1/2) ÷ (4/5)
1953	22.5	8.6	24.3	38.1	40.0	60.6
1954	24.5	7.8	24.6	31.5	39.1	61.7
1955	37.9	4.9	14.6	12.9	22.3	65.7
1956	29.4	4.4	11.1	15.0	19.8	56.1
1957	23.3	5.9	12.4	25.3	24.7	50.2
1958	28.3	6.6	19.4	23.4	30.6	63.6
1959	35.5	6.7	11.9	18.8	19.6	61.0
1960	36.3	4.9	7.8	13.6	13.2	58.8
1961	31.7	11.6	19.3	36.6	31.8	60.6
1962	33.0	12.4	18.5	37.7	31.6	58.7
1963	49.1	13.8	17.9	28.0	25.1	71.2
1964	51.6	14.7	17.0	28.5	23.6	72.1

Source: Calculated from data in Table 39.

b. member commercial bank bill holdings as a percentage of total bank holdings of marketable Federal debt,

c. member bank holdings of within one year marketable Federal debt as a percentage of total marketable Federal debt holdings.

d. bill holdings of commercial banks as a percentage of the total quantity of bills available to the public,

e. bank holdings of within-one-year marketable Federal debt as a percentage of the total quantity of marketable Federal debt within one year of maturity available to the public, and finally,

f. the ratio of commercial bank bill holdings to bank holdings of within one year debt as a percentage of the ratio of q_b to q.

The results indicate that bill holdings as a percentage of within-one-year marketable debt have increased over most of the period, and although the upward trend is not as strong, there has been an increase in bills as a percentage of total bank holdings of Federal marketable debt. Bank holdings of marketable debt of less than one year to maturity as a percentage of total marketable debt holdings has shown considerable volatility, with no apparent trend. Also bank bill holdings as a percentage of bills in the hands of the public has varied considerably from 24.6 per cent in 1954 down to 7.8 per cent in 1960--with a considerable jump in 1958 when the percentage moved to 19.4--and, since the 1960 low, the percentage has remained at approximately 18 per cent. The percentage of within-one-year holdings to total holdings of marketable debt again shows little if any trend, and significant fluctuation.

Perhaps the most interesting result is the last column of the percentages, showing the ratio of commercial bank bill holdings to bank holdings of within-one-year securities as a percentage of the ratio q_b/q. There is some volatility to this percentage with the low value of 50.2 in

1957 and the high of 72.1 in 1964. Although the movement of the percentage is interesting, the average level of these percentages indicates a bank preference of non-bill short-term debt with the percentage of bank holding of bills to total one-year-holdings lower than the percentage of bills available to within-one-year available.

These percentages, and their fluctuations, indicates that the determinants of commercial bank portfolio policy require a great deal more analysis than this study provides. However, since free reserves were so important in "explaining" movements in the bill rate in the last Chapter, an attempt was made to regress commercial bank bill holdings on some of the independent variables used to explain the bill rate. The independent variables used were: country bank reserves (R_c), non-country bank reserves (R_1), Treasury deposits at commercial banks (T), and the level of the bill rate (r_b) or as a ratio to the discount rate (r_b/r_d). The dependent variable was expressed alternatively in the form of level of bill holdings by commercial banks (C_b); level of bill holdings as a percentage of holdings of marketable debt within one year of maturity (C_b/C_1); level of bill holdings as a percentage of total bills available to the public C_b/q_b; and finally--$C_b/C_1 \div q_b/q$. Most of the regression equations were estimated both with and without the use of monthly dummy seasonal variables. Bill holdings of commercial banks, free reserves, and Treasury deposits are expressed in billions of dollars (5.674) and the rates are expressed as percentages (3.21).

The estimated equations are summarized in Table 42. The multiple coefficients of determination are relatively low, and the Durbin-Watson statistics indicate a high probability of autocorrelation of residuals.

TABLE 42.--Selected regression equations relating member commercial bank holdings of Treasury bills to: non-country bank free reserves (R_1), country bank free reserves (R_c), Treasury deposits in commercial banks (T), and the bill rate (r_b or r_b/r_d), monthly: January, 1953-December, 1964

Equation number	Equation and (standard error)	R^2	d'
(1")	$C_b = -4.192 + \underset{(.516)}{3.285R_1} + \underset{(1.616)}{9.656R_c} + \underset{(.102)}{3.263T} + \underset{(.197)}{2.110r_b}$	.63	
(2")	$C_b = + \underset{(.532)}{3.112R_1} + \underset{(1.993)}{7.964R_c} + \underset{(.122)}{.583T} + \underset{(.238)}{1.822r_b} - \underset{\underline{1}}{3.194i}$		
	$- \underset{\underline{2}}{3.264ii} - \underset{\underline{7}}{4.325iii} - \underset{\underline{4}}{3.627iv} - \underset{\underline{8}}{4.461v} - \underset{\underline{10}}{4.691vi}$		
	$- \underset{\underline{11}}{4.728vii} - \underset{\underline{12}}{4.863viii} - \underset{\underline{9}}{4.582ix} - \underset{\underline{5}}{4.113x} - \underset{\underline{6}}{4.124xi}$		
	$- \underset{\underline{3}}{3.453xii}$	.68	.43
(3")	$C_b/C_1 = .274 + \underset{(.036)}{.189R_1} - \underset{(.091)}{.386R_c} + \underset{(.007)}{.018T} + \underset{(.064)}{.225r_b/r_d}$	.35	.50
(4")	$C_b/C_1 = + \underset{(.034)}{.185R_1} - \underset{(.094)}{.608R_c} + \underset{(.007)}{.034T} + \underset{(.064)}{.066r_b/r_d}$		
	$+ \underset{\underline{1}}{.512i} + \underset{\underline{3}}{.465ii} + \underset{\underline{8}}{.395iii} + \underset{\underline{5}}{.432iv} + \underset{\underline{12}}{.322v}$		
	$+ \underset{\underline{11}}{.333vi} + \underset{\underline{9}}{.387vii} + \underset{\underline{10}}{.378viii} + \underset{\underline{6}}{.432ix} + \underset{\underline{7}}{.427x}$		
	$+ \underset{\underline{4}}{.439xi} + \underset{\underline{2}}{.495xii}$	.51	.54
(5")	$C_b/q_b = \underset{(.014)}{.009R_1} + \underset{(.051)}{.210R_c} + \underset{(.003)}{.005T} - \underset{(.006)}{.010r_b} + \underset{\underline{2}}{.124i}$		
	$+ \underset{\underline{5}}{.110ii} + \underset{\underline{12}}{.083iii} + \underset{\underline{7}}{.103iv} + \underset{\underline{10}}{.092v} + \underset{\underline{9}}{.097vi}$		
	$+ \underset{\underline{8}}{.098vii} + \underset{\underline{11}}{.092viii} + \underset{\underline{6}}{.106ix} + \underset{\underline{3}}{.117x} + \underset{\underline{4}}{.111xi}$		
	$+ \underset{\underline{1}}{.135xii}$	.56	.16

TABLE 42.--(continued)

Equation number	Equation and (standard error)	R^2	d'
(6") $C_b/C_1/q_b/q_1$	$= .590 + \underset{(.036)}{.148}R_1 - \underset{(.090)}{.066}R_c + \underset{(.007)}{.001}T$		
	$+ \underset{(.063)}{.145}\, r_b/r_d$	.13	.70
(7") $C_b/C_1/q_b/q_1$	$= \underset{(.029)}{.159}R_1 - \underset{(.109)}{.157}R_c + \underset{(.007)}{.021}T + \underset{(.013)}{.079}r_b/r_d$		
	$+ \underset{\underline{1}}{.217i} + \underset{\underline{2}}{.213ii} + \underset{\underline{8}}{.158iii} + \underset{\underline{4}}{.190iv} + \underset{\underline{12}}{.118v}$		
	$+ \underset{\underline{11}}{.120vi} + \underset{\underline{9}}{.155vii} + \underset{\underline{10}}{.134viii} + \underset{\underline{7}}{.163ix}$		
	$+ \underset{\underline{5}}{.169x} + \underset{\underline{6}}{.168xi} + \underset{\underline{3}}{.212xii}$	.62	.52

Matrix of simple correlation coefficients for levels of variables

	C_b	R_1	R_c	T	r_b
C_b	1.000				
R_1	.483	1.000			
R_c	.183	.585	1.000		
T	.444	.309	-.0002	1.000	
r_b	.310	-.378	-.714	.158	1.000

For the most part the partial regression coefficients are 1.6 times as large as the respective standard errors although there are several exceptions depending on the form in which the dependent variable is expressed. Also, due to autocorrelation of residuals, the standard errors are understated.

The inclusion of dummy monthly seasonal variables illustrates a strong seasonality of bank holdings of bills, regardless of the form in which holdings are brought in as the dependent variable. Comparison of the ranking of the seasonal regression coefficients shows little variability between equations 2", 4", 5", and 7" with December, January, and February generally being well above "normal" and May, June, July, and August generally below the "normal" level.[257]

The inclusion of dummy variables, however, does little to reduce the degree of autocorrelation of residuals.

In equations 1" and 2" the dependent variable is the level of member commercial bank bill holdings. The partial regression coefficients are large relative to the biased standard errors, with the dummy seasonal variables increasing the coefficient of multiple determination in equation 2". The only partial regression coefficient which is changed by the inclusion of dummy variables is T, Treasury deposits in member commercial banks, which decreases from 3.263 to .583.

The relationship between bill holdings and the bill rate is strong, indicating a one per cent increase in the bill rate (from two to three per cent) would "cause" an increase in bank holdings by approximately two billion dollars. However, if bank holdings of bills meet the liquidity requirement of commercial banks and are relatively insensitive to levels of the bill rate, it would be more sensible to measure the bill rate relative to a substitute in commercial bank portfolios. Therefore, in equations 3" through 7" the bill rate is expressed relative to the discount rate, r_b/r_d. The expected sign of this relationship is positive

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[257] An estimation of the seasonality of member bank holdings of bills is presented below.

indicating that the greater the bill rate relative to the discount rate the larger will be bank holding of bills, assuming the free reserves variables remain constant. The *ceteris paribus* assumption of free reserves is reasonable enough since rediscounting at the Federal Reserve Bank has the same effect on free reserves as a reduction of bill holdings and vice versa. In other words, free reserves may remain constant as commercial banks substitute bills and rediscounting, dependent upon the relative rates.

Equations 3" and 4" yielded slightly poorer results as measured by the multiple coefficients of determination. Also there was no improvement in the calculated degree of autocorrelation. The addition of dummy seasonal variables in equation 4" increased the partial regression coefficients for R_c and T, and decreased the coefficient for r_b/r_d.

Equation 5" produced relatively poorer partial regression coefficients relative to the calculated standard errors, with the coefficient for R_1 less than the standard error and near a zero value. Only the regression coefficient for R_c is large relative to the standard error. The dummy seasonal variables account in large part for the multiple coefficient of determination of .56.

The dummy seasonal variables in equation 7" increase the coefficient of determination from .13 in equation 6" to .62. This indicates an important degree of seasonality in bank holdings of bills as a percentage of bank holdings of one year marketable debt relative to q_b/q_1 that is not explained by the other dependent variables. It is possible that the "unexplained" variance in the dependent variable may be caused by the variability in the ratio q_b/q_1. However, a comparison of the rankings of the coefficients of the dummy seasonal variables of various forms of the dependent variables indicates that the seasonal factors of equations 7" are not very different from those estimated in equations 2", 4", and 5". A comparison of the common partial regression coefficients between equations 6" and 7" indicate a change in the coefficient from R_c from -.066 to -.157, an increase in the coefficient for T from .001 to .021, and a decrease in the coefficient for r_b/r_d from .145 to .079. All three of these coefficients are larger relative to the standard errors in equation 7" than in equation 6".

These estimated equations, although characterized by positively autocorrelated residuals, indicate that free reserves of country banks and of non-country banks may be important in explaining commercial bank holdings of bills. The results, however, may be spurious instead of cause and effect related; for instance, a purchase of bills, ceteris paribus, reduces free reserves of the bank making the purchase. It is difficult to evaluate these results. The determinants of commercial bank portfolio policy are much more complex than the relationships presented here. Possibly variables such as bank debits, deposit turnover, or System holding would assist in satisfactorily explaining commercial bank holdings of bills on a monthly basis. The bill rate, either as a level or as a ratio with the discount rate, is highly related to bank bill holdings in the multiple regression estimates. It has been argued that bank holdings of bills need not be sensitive to bill rate movements, and instead, the bill rate is partially dependent upon changes in the level of bank holdings. It is quite apparent that a theoretically sound system of structural equations is necessary to measure the interdependence of these variables.

In the latter part of this Chapter, an attempt is made to measure the partial effect on the bill rate of changes in the level of commercial bank holdings of bills.

Foreign governments and banks

Foreign governments and banks maintain large portfolios of short-term Federal marketable debt. Although bill holdings alone are not available, Table 43 shows monthly holdings of Treasury bills and Certificates of Indebtedness for the period January, 1953 through December, 1964. The series shows no important degree of seasonality on a ratio-to-twelve-month-average measurement, and generally shows a rather steady upward trend. The low values, $2.898 billion, for international holdings of short-term marketable Federal debt is registered at the beginning of the period in February, 1953, and the high value, $9.121 billion, in June, 1963. The series is relatively stable, although some rather large monthly changes occur in the period 1962-1964.

Recently some empirical estimates have been attempted to measure the sensitivity of this sector's holdings to interest rate changes or differentials in bill rates between the United States and other money market centers.[258] Recently, the Federal Reserve Bulletin has begun to present statistics to indicate the yield spreads (accounting for forward currency rates) between bill rates in the United States and the United Kingdom and Canada indicating whether the spread favors short-term-fund inflows or outflows with these two countries.[259] Indeed, it has been the

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[258] An example is provided by: J. L. Stein, "International Short-Term Capital Movements," The American Economic Review, Vol. LV, No. 1 (March, 1965), pp. 40-66. For a description of the activity in the short-term market by the international sector, see: Andrew F. Brimmer, "Foreign Banking Institutions in the United States Money Market," The Review of Economics and Statistics, Vol. XLIV, No. 1 (February, 1962), pp. 76-81.

[259] The weekly series was initiated regularly in late 1964. The article by Samuel I. Katz, "Yield Differentials in Treasury Bills, 1959-64," Federal Reserve Bulletin, Vol. 50, No. 10 (October, 1964), pp.1241-1260, carried the series back to the beginning of 1959.

TABLE 43.--International sector holdings of U. S. Treasury bills and Certificates of Indebtedness: monthly, 1953-1964 (in billions of dollars)

Month	1953	1954	1955	1956	1957	1958
January	2.938	3.630	3.819	4.450	5.033	5.534
February	2.898	3.662	3.670	4.530	4.859	4.996
March	2.992	3.648	3.655	4.820	4.909	4.600
April	3.180	3.615	3.816	4.798	4.837	4.372
May	3.190	3.648	3.817	4.883	4.878	4.429
June	3.144	3.458	3.849	4.746	4.875	4.297
July	3.196	3.531	3.827	4.742	5.034	4.408
August	3.412	3.470	3.832	4.790	5.138	4.800
September	3.517	3.615	4.008	4.969	5.021	5.115
October	3.587	3.635	4.150	5.039	5.410	5.322
November	3.585	3.612	4.166	4.790	5.427	5.340
December	3.445	3.611	4.209	5.151	5.371	5.372
Month	**1950**	**1960**	**1961**	**1962**	**1963**	**1964**
January	5.404	7.464	7.681	6,853	8.888	8.651
February	5.782	7.521	7.351	7.115	8.761	8.498
March	5.467	7.376	7.417	7.614	8.909	8.108
April	5.661	7.233	7.090	7.391	9.021	7.803
May	6.012	7.309	7.078	7.691	9.083	7.887
June	6.275	7.339	7.164	8.243	9.121	7.941
July	6.721	7.406	7.130	8.000	8.928	8.000
August	6.878	7.638	7.323	8.159	9.027	8.254
September	7.128	7.546	7.548	9.010	8.968	8.281
October	7.375	7.688	7.459	9.569	8.857	8.238
November	7.416	7.328	7.293	9.583	8.689	8.554
December	7.475	7.639	7.512	9.330	8.690	8.799

Sources: From 1952 through 1960, Supplement to Banking and Monetary Statistics, "International Finance," (Section 15) Board of Governor's of the Federal Reserve System, 1962; from 1961 through 1964, Federal Reserve Bulletin, each monthly issue, "Short-Term Liabilities to Foreigners." For the period 1961 through mid-1963, special issues held by International Agencies were subtracted out. For the complete period, 1953-1964, other holdings were added to governmental and bank holdings.

deliberate policy of the Treasury and Federal Reserve System to bid up the short-term rate as an inducement for foreign governments and banks to hold financial balance of payments claims against the U. S. in the form of

Federal marketable debt instead of settling the account through gold transfers. The Treasury and the Federal Reserve System have been successful in bidding up the bill rate to a level remaining near the Canadian bill rate in the latter half of 1963 and throughout 1964. The U. S. bill rate attained a level near the United Kingdom rate in late 1963--early 1964, but due to the recent Sterling crisis was more than 2.5 per cent points below the London rate at the end of 1964 as the United Kingdom rate rose to over 6.4 per cent (adjusted to discount basis for comparability with the U. S. rate). However, given the percentage discount on forward pounds, the effective differential still favored arbitrage movements toward the New York market.

Nevertheless, it has been pointed out that these differentials are not the overriding consideration in the determination of the level of holdings of short-term Federal marketable debt by the international sector. The determinant factors of international holdings are more basic economic factors such as balance of payments and relative macroeconomic trends. Roland I. Robinson has pointed out that:

> ...although interest rates are somewhat influential in explaining the movements of funds (and they often move for other reasons--usually in search of economic and political stability), the funds themselves may have considerable influence on rates.[260]

The purpose here is not to examine the determinants of holdings by the international sector, but rather to measure the effects of increased sector holdings on the bill rate. Again, there is not a clear direction of cause and effect, but rather interdependence between holdings and the rate. Given the quantity of bills available, increased demand by the international sector, _ceteris paribus_, should lower the bill rate.

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[260] Roland I. Robinson, _Money and Capital Markets_ (New York: McGraw-Hill Bank Co., 1964), p. 352.

Non-financial corporations play an important role in the Treasury bill market by holding large quantities of regular weekly bill issues and the majority of tax anticipation bills. Recently corporations have been important suppliers of credit to U. S. Government securities dealers. The level of holdings of Treasury bills reporting to the Treasury survey are provided in Table 44 for the period 1959 through December, 1964. The corporations reporting to the survey account for approximately 50 per cent of total corporate holdings, although it is probable that greater than one-half of the bill holdings by the non-financial corporation are included in the survey. In Chapter II above the empirical evidence indicated that non-financial corporations were not very sensitive to levels or changes in the bill rate. James S. Duesenberry has recently stated that:

> In spite of a number of efforts to do so, I believe no one has found a statistically significant relationship between short-term variations in bill yields and the distribution of corporate liquidity between cash and governments.[261]

Duesenberry listed some of the more important reasons for corporations holding demand deposits or short-term, highly marketable assets.

> First, some minimum of liquid assets is required to cover the day-to-day variations in receipts and expenditures without continually borrowing and repaying bank loans. Second, many corporations have wide seasonal variations in their cash inflows and outflows....Third, most, though not all, business firms seem to feel that it is desirable to fund all or a very large part of their tax liability....Fourth, most firms wish to have liquidity to meet the problems arising from a decline in cash flow from current operations during a depression.[262]

Ernest Block has concluded in a recent study that there is indeed a close relationship between corporate holdings of marketable Federal debt

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[261] James S. Duesenberry, "The Portfolio Approach to the Demand for Money and other Assets," The Review of Economics and Statistics, Vol. XLV, No. I, Part 2 (Supplement: February, 1963), p. 15.

[262] *Ibid.*, p. 11.

TABLE 44.--Non-financial corporation holdings of Treasury bills of those corporations reporting to the Treasury Survey; monthly, January, 1960 to December, 1964

Month	1960	1961	1962	1963	1964
January	6.832	5.800	5.598	7.050	6.749
February	7.393	6.313	6.114	7.736	7.488
March	5.317	4.907	5.257	6.597	6.290
April	5.935	5.466	5.698	7.175	6.878
May	5.941	6.047	6.217	8.178	7.429
June	4.579	4.885	5.213	6.325	5.845
July	4.802	5.509	5.481	6.377	6.073
August	4.983	5.732	5.826	6.906	5.864
September	4.256	4.539	4.609	5.545	4.868
October	5.041	5.391	5.812	6.405	5.564
November	6.100	6.165	7.076	6.932	5.519
December	5.599	5.466	6.551	6.178	5.043

Sources: Federal Reserve Bulletin and Treasury Bulletin, various monthly issues, September, 1960 through March, 1965.

and corporate accrued tax liabilities.[263] He noted however that large manufacturing corporations consistently held a greater volume of securities than accrued tax liabilities, while the reverse was true of "smaller" corporations. Block defined "free governments" as holding of Federal securities by large manufacturing corporations above their accrued tax liabilities, and attempted to explain the movement of "free governments" over the period 1948-1961. Block concluded that: "There is no interest-rate relationship

[263] Ernest Block, "Short Cycles in Corporate Demand for Government Securities and Cash," The American Economic Review, Vol. LIII, No. 5 (December, 1963), pp. 1058-1077.

that can consistently explain either the level of holdings or changes in holdings,"[264] although "free governments" moved cyclically between limits of near zero in late 1951-early 1952 to over $4 billion in 1959. Block indicates that holdings of "free governments" are dependent on "real" factors such as inventories and investment plans. Nevertheless, the seasonal movement of that portion of Federal securities associated with accrued tax liabilities is greater than "free governments" even for the peak level of "free governments" in 1959.

Block points out that the advent of negotiable certificates of deposit and the realization of corporate treasurers that there was little risk in holding sales finance paper allowed great diversification in the holding of short-term assets.[265] Stephen H. Axilrod and Janice Krummack have remarked that the market for negotiable certificates of deposits "may have taken some of the daily pressure off bill rates because these certificates provide investors, mainly businesses, with another instrument through which they could make adjustments in their liquidity positions."[266] Table 44 indicates that corporations reporting in the Treasury survey held a smaller volume of bills in every month of 1964 than the corresponding month in 1963. Nevertheless, a breakdown of the bill holdings of Treasury bills of those corporations reported in the Treasury survey indicates the importance of accrued tax liabilities. As of December 31, 1964, the 469

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[264] Ibid., p. 1064.

[265] Ibid., pp. 1074-1075.

[266] Stephen H. Axilrod and Janice Kummack, "Federal Reserve Security Transactions, 1954-63," Federal Reserve Bulletin, Vol. 50, No. 7 (July, 1964), pp. 834-835.

surveyed corporations held $1.371 billion of their $5.043 billion total bill holdings in the form of tax anticipation bills.[267] Except for holdings of commercial banks, other reporting sectors held relatively small quantities of tax anticipation bills, and if the residual holdings of tax anticipation bills in the "all other" category were added to corporate holdings of TA's, this would account for $2.643 billion of the total tax anticipation bills outstanding of $4.008 billion, or approximately 65 per cent of the total. Commercial banks held nearly a billion dollars of the remainder.

State and local governments

State and local governments invest idle balances from general operating funds in Treasury bills and other short-term marketable debt. Also state pension funds and trust funds, which are not included in these series, are heavily invested in Federal securities, but in longer maturities than bills, according to a survey carried out by the Public Affairs Research Council of Louisiana in 1956, 12 states were restricted to Federal securities in regard to investing idle balances from general funds while 18 other states were authorized, in addition, to purchase their own issues.[268] A wide range of authority exists in the investment of local funds.

For those governmental units holding Federal debt, holdings will vary because of seasonality in receipts and payments. For state and local

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[267] Treasury Bulletin, February, 1965.

[268] Investment of Idle Cash Balances by State and Local Governments. Advisory Commission on Intergovernmental Relations, Washington, D. C., January, 1961, p. 16.

government general fund expenditures, school expenditures may be reduced in the summer months, but this is probably the only common cause of large fluctuations in expenditures. The variability of revenues will probably be more pronounced, dependent of course, on the type of taxes and schedule of collections. The majority of the 36 states having an income tax have a filing date corresponding to that of the Federal government, April 15. Also, most of the states require withholding, with the employer submitting returns quarterly, although it appears that more states are moving toward a requirement of monthly employer returns.[269] Essentially the same states which require personal income tax have a form of corporate income tax but the rates are relatively low, and the revenue derived small relative to the personal tax.

By far the greatest single source of revenue for state governments is derived from the general sales tax, which now accounts for about 25 per cent of total state revenues. Of the 37 states relying on a general sales tax in 1964, over one-half require monthly returns, with the remainder requiring quarterly returns. Some states permit either monthly or quarterly returns.[270]

The property tax provides the greatest revenue for local governments with county governments, city governments, and "authorities" sharing to widely varying degrees the assessment, collection, and administration

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[269] Tax Overlapping in the United States, 1964. Advisory Commission on Intergovernmental Relations, Washington, D. C., July, 1964, p. 128.

[270] Ibid., p. 106.

of the tax under the supervision of the state governments. The collection of the property tax is normally on an annual basis.

A great deal of aggregation is entailed when state and local government holdings of bills are examined. Seasonality in the aggregate holdings results from a weighted average of state and local government revenue--expenditure flows and investment policies. The series of state and local government general fund holdings as measured by the Treasury survey are shown in Table 45. Until January, 1964 the survey covers 295 general funds, and since this date, 316 general funds are included. Therefore, in addition to the inadequacies due to length and coverage, this series is also inconsistent in the degree of coverage. Treasury estimated total holdings of Federal debt for state and local governments as of the end of December, 1964 were $21.6 billion. State and local governments reporting to the Treasury survey accounted for approximately $15.0 billion of the total with more than 30 per cent of these holdings in maturities less than one year--slightly less than $4 billion of this in Treasury bills. Over-20-years-to-maturity Federal securities accounted for roughly the same percentage of holdings as the one year category.

Dealers

Dealer portfolios, at any point in time, reflect rather large bill holdings. Since seventy-five per cent, more or less, of the total volume of transactions in the Government securities market are in the form of bills, dealers require an "inventory" of bills in order to satisfy purchase orders. Dealers earn an interest return on securities in their portfolio. However, a dealer has to borrow to maintain a position and the rate charged him is usually enough higher than the bill rate to discourage any attempts

TABLE 45.--Holdings of Treasury bills of general purpose funds of state and local government reporting to the Treasury survey; monthly, January, 1961 through December, 1964 (in billions of dollars)

Month	1961	1962	1963	1964
January	2.384	2.566	3.456	4.263[a]
February	2.693	2.800	3.684	4.569
March	2.839	2.937	3.506	4.694
April	2.747	3.259	4.119	5.404
May	2.771	3.661	4.184	5.334
June	2.522	3.527	4.246	5.136
July	2.643	3.614	4.125	4.891
August	2.701	3.541	4.306	5.174
September	2.604	3.336	3.896	4.772
October	2.398	3.181	3.553	4.577
November	2.326	2.992	3.393	4.367
December	2.517	3.282	3.896	3.961

[a]Beginning in January, 1964, approximately 316 units of government are reporting, whereas prior to this data approximately 295 units were reporting.

Sources: Federal Reserve Bulletin and Treasury Bulletin, various monthly issues, September, 1964 through March, 1965.

to break even on maintenance of a portfolio. The dealers earn their return by the difference in the price at which they buy and sell securities. In periods when the bill rate is increasing (prices decreasing), it would be expected that a dealer's portfolio would be smaller than if the rate were decreasing, and *vice versa*; therefore, an inverse relationship should be expected. However, the relationship is much more complex, principally because dealers are not acting simply as brokers, and stand ready to buy or sell regardless of portfolio considerations. If market conditions are such that other institutional sectors are generally reducing their holdings and dealer portfolios are expanding, interest rates will increase as dealers lower bid prices to reduce upward pressures on positions.

The monthly average daily value of dealer holdings of Federal marketable securities maturing within one year are shown in Table 46, for the period September, 1960 through December, 1964. The low average daily position, $1.6 billion, was registered in March, 1961, and the high value, $3.6 billion, in January, 1963. Although these holdings are largely bills, a highly variable proportion are in other types of near-maturity issues. Bill positions are available on a weekly basis for the period October, 1957 through December, 1958 from the Treasury-Federal Reserve Study of the Government Securities Market, and from September, 1960 through December, 1961 from unpublished information furnished by the Market Statistics Division of the Federal Reserve Bank of New York. These sets of data, however, are not exactly comparable, and are not utilized in any of the empirical estimates.

Dealer transactions

Data on dealer transactions are available on the same basis as dealer positions and for identical periods. Transactions in Government marketable securities of less than one year maturity are shown in Table 47. The expected relationship of this variable with the bill rate may be either positive or negative depending on whether the volume of transactions is induced from the demand or the supply side. If the increased volume of gross transactions is demand induced the relationship with the bill rate should be positive, if supply induced the relationship should be negative. Therefore, the level of transactions may be either positively or negatively

TABLE 46.--Dealer positions in U. S. Government Securities having less than one year to maturity, monthly average at daily figures; January, 1961 through December, 1964 (in billions of dollars)

Month	1961	1962	1963	1964
January	2.338	2.589	3.622	3.218
February	2.128	1.914	2.863	2.787
March	1.600	2.721	2.439	2.486
April	2.115	3.388	2.934	2.316
May	2.227	2.985	2.810	2.670
June	1.973	3.398	2.666	3.217
July	2.247	2.818	2.505	3.121
August	2.350	2.484	2.871	2.978
September	2.339	2.643	3.099	3.302
October	3.004	2.991	2.899	2.966
November	3.272	3.309	3.008	3.073
December	2.655	3.829	2.800	2.675

Source: Federal Reserve Bulletin; monthly issues, September, 1960 through December, 1964.

TABLE 47.--Dealer transactions in U. S. Government Securities having less than one year to maturity, monthly averaged daily figures; January, 1961 through December, 1964 (in billions of dollars)

Month	1961	1962	1963	1964
January	1.113	1.478	1.485	1.656
February	.934	1.520	1.646	1.336
March	1.144	1.332	1.241	1.361
April	1.200	1.350	1.438	1.528
May	1.092	1.338	1.160	1.264
June	1.143	1.357	1.208	1.201
July	1.441	1.457	1.440	1.433
August	1.173	1.318	1.060	1.099
September	1.185	1.432	1.208	1.214
October	1.389	1.517	1.261	1.476
November	1.295	1.266	1.300	1.426
December	1.328	1.446	1.348	1.596

Source: Federal Reserve Bulletin; monthly issues, September, 1960 through December, 1964.

related to dealer holdings depending on whether a supply-induced volume adds to holdings or a demand-induced volume reduces portfolios.

Seasonality of Holdings

Given a fixed stock of bills available to the public, seasonality in holdings by various sectors would cause seasonality in the bill rate corresponding to a weighted average of the seasonal holdings of the sectors. The Treasury, by tailoring bill issues to demand, could offset bill rate seasonality by supplying bills inversely to "net" demand seasonality. The Federal Reserve System, as well, could adjust their holdings through open market operations to offset seasonality.

In order to gain some information regarding the relative seasonality of the bill rate, the quantity of bills, and the holding of the sectors just reviewed, the specific seasonal factors have been calculated for each month. The principal difficulties in these comparisons are the differences in the quality of the data and the inadequate length of the series for non-financial corporations, state and local governments, dealer positions, and transactions, also holdings are end-of-month values which do not necessarily reflect the level of holdings during the month. The series for state and local governments, for instance, is only four years long, with a change in coverage in the last year.

Specific seasonal factors were calculated by a ratio-to-twelve-month-moving-average method. The method centers the average, which with the end-of-month data, causes the seasonal factors for several of the series, especially corporate holdings, to appear to belong to the month prior to the actual location. The seasonal factors calculated for the short series should be interpreted as being crudely descriptive and highly conjectural. A subjective evaluation of the consistency and stability of the seasonal factors will be provided for each series.

Table 48 provides the specific seasonal factors for the bill rate, the quantity of bills issued by the Treasury, the quantity of bills in the hands of the public, System holdings, commercial bank holdings, non-financial corporation holdings, state and local government holdings, dealer positions, and dealer transactions. The bill rate factors are those calculated for the period 1952-1964 in Chapter III and their quality has been discussed. The quantity-of-bills-series were calculated for the period 1952-1964 and show a high degree of stability. The

TABLE 48.--Specific seasonal factors for: Treasury bill rate (r_b), quantity of bills issued by the Treasury less agency and trust fund holdings (Q_b), quantity of bills available to the public (q_b), Federal Reserve System holdings of bills (S), member commercial bank holding of bills (C_v), nonfinancial corporation holding of bills (B), state and local government holding of bills (G), Government securities dealers position in Federal marketable securities having less than one year to maturity (D), and dealer transactions in securities within one year of maturity (V); for time periods indicated

Month	r_b 1952-1964	Q_b 1952-1964	q_b 1952-1964	S 1952-1964	C_b 1952-1964	B 1960-1964	G 1961-1964	D 1961-1964	V 1961-1964
January	102.5	103.6	104.9	83.8	114.2	104.4	95.7	112.8	108.2
February	98.8	104.0	104.2	72.8	106.2	114.8	100.5	96.6	110.8
March	96.7	99.6	101.3	82.5	82.8	95.4	97.7	85.8	95.9
April	99.1	99.2	100.3	82.6	94.1	103.0	109.5	97.9	106.2
May	95.8	99.3	99.5	91.2	91.2	113.6	113.2	94.3	92.1
June	94.2	93.3	93.1	101.3	87.3	91.4	106.3	110.5	90.1
July	95.0	96.9	95.7	110.7	97.1	93.4	105.9	94.8	107.1
August	101.0	98.2	99.5	110.7	93.3	99.4	106.3	99.1	92.1
September	103.3	97.9	97.9	97.4	102.0	80.4	98.3	97.1	96.1
October	102.8	100.4	100.0	105.3	106.4	94.5	90.6	102.8	105.3
November	103.1	103.6	101.1	122.3	104.6	110.7	85.3	109.4	96.5
December	107.2	104.0	102.1	139.5	120.7	99.1	90.4	99.8	99.7

Source: Calculated from series shown in preceding Tables.

holdings of the Federal Reserve System for the period 1952-1964 are quite volatile, and although the ratios-to-moving-average vary considerably, the specific seasonal factors seem fairly reliable. Commercial bank holdings for the period 1952-1964 are volatile, but the seasonal factors exhibit considerably more consistency than System holdings. The seasonal factors for bill holdings for non-financial corporations are fairly consistent as are the factors for state and local government holdings, but the series are extremely short and the coverage incomplete. Seasonal factors for dealer holdings and dealer transactions are also calculated from short time series, but coverage is relatively complete. However, the volatility of the series causes the seasonal factors to be unstable and highly tentative. The series for the year 1960-1964 or 1961-1964 are used to measure seasonality for a period where some argue that bill rate seasonality was subsiding. Despite the inadequacies some tentative conclusions regarding whether bill rate seasonality arises on the demand side or the stock side are possible.

Beginning with commercial bank holdings, a rather large seasonal variation is apparent with holdings increasing from August to the high in December, declining to the low in March, with relatively large seasonal fluctuations between April and August. The quantity of bills issued by the Treasury shows a seasonal pattern above and below "normal" in approximately the same months as bank holdings, indicating that the Treasury may be issuing bills in response to periods of high demand. Bank holdings above "normal" would indicate downward pressure on the bill rate, while the Treasury issues above "normal" would provide upward pressure on rates.

The bill holdings of the Federal Reserve System exhibit extremely large seasonal movements, although the quantity of holdings are smaller than commercial bank holdings, and only a fraction of total bills issued. The effect of System holdings in offsetting the seasonal effects of Treasury issues of bills is easily discerned by comparing the seasonality of the quantity of bills in the hands of the public with the seasonality in the quantity of bills issued by the Treasury. System holdings appear to counteract seasonality in Treasury bill issues in the months of March, April, May, November, and December; and to accentuate seasonality in the months of January and February, with the factors for most other months being relatively neutral.

Corporation holdings of bills indicate holdings are low at the end of the quarters--March, June, September, and December. The end-of-month data reflect that payment of corporate taxes has already been accomplished, and it is expected that very large bill quantity changes for this sector arise just as the month ends; therefore, it would probably be more meaningful for the corporate sector's factors to be viewed as the <u>beginning</u> of the following month instead of the <u>end</u> of a current month--shifting all factors forward one month.

State and local government holdings appear to do as much as any other sector to "cause" bill rate seasonality arising from the demand side. The calculated seasonal factors indicate that state and local governments consistently hold relatively large quantities of bills when the bill rate is seasonally low and, hold relatively small quantities when the bill rate is seasonally high. The largest seasonal factor is for May (113), and the smallest factor is for November (85).

Dealer positions in marketable securities of less than one year to maturity exhibit rather large seasonality, being above "normal" (by decreasing magnitude) in January, June, November, and October; below "normal" (by increasing magnitude) in March, May, July, February, September, and April; and near normal in August and December. Comparing the seasonal factors of dealer positions with the seasonal factors of the bill rate indicate that the above or below "normal" factors correspond in nine of the twelve month indicating generally that dealer positions act to offset the seasonality of the bill rate in the majority of the months.

Dealer transactions in marketable Federal debt within one year to maturity indicate larger than average transactions in January, February, April, July, and October, with February having the largest factor. Transactions appear to be lightest in the months of May, June, and August.

To summarize, an example of the offsetting and contributing factors to bill rate seasonality for the month of January are discussed. The bill rate seasonal factor for this month is roughly four per cent above average. The quantity of bills issued by the Treasury (high) and System holdings (low) in January are such that they contribute toward the seasonality of the rate. If a relatively larger quantity of bills are available for this month, some sector holdings must be above normal, and it is seen that commercial bank holdings and dealer positions are both 13 to 14 per cent above average, and corporate holdings about four per cent above average. Only state and local government holdings are below average for January and only by about four per cent. The relatively larger quantity of bills available to the public and the lower than average holdings of the state and local sector contribute toward upward pressure on the bill rate which apparently is not offset by the higher than average holdings of commercial banks, dealers, and non-financial corporations.

Regression Results Emphasizing Sector Holdings

It is obvious that the quantity and quality of data on sector holdings is not adequate to do any extensive empirical estimation of the effect on the bill rate by changes in holding patterns. A few regression equations were calculated in order to see if the algebraic signs were appropriate. The independent variables in these equations, and the expected relationship with the bill rate--positive (+) or inverse (-) are shown in Table 49.

TABLE 49.--Independent demand variables utilized in explaining bill rate movements and the expected relationship with the rate; positive (+) or inverse (-)

Symbol	Variable	Expected sign
C_b	Commercial bank holdings of bills	-
S	Federal Reserve System holdings of bills	-
I	International government and bank holdings of bills and certificates	-
B	Non-financial corporation holdings of bills	-
G	State and local government general fund holdings of bills	-
D	Dealer positions in marketable Federal securities within one year of maturity	-
V	Dealer transactions in marketable Federal securities within one year of maturity	+ or -

Increased holdings by a sector are indicative of a shift in the demand schedule to the right and decreased holdings indicative of a shift in the schedule to the left. Assuming however, that the quantity of bills available to the public to hold is constant, increased holdings by one sector require that other sector holdings are reduced by the same amount. Equation 8" was estimated for the period January, 1953 through December, 1964 utilizing holdings for those sectors for which data are available over the complete period--commercial banks, the Federal Reserve System and international governments and banks. These variables resulted in the equation:

$$(8'')\quad r_b = .743 - \underset{(.038)}{.118C_b} - \underset{(.065)}{.051S} + \underset{(.040)}{.419I}$$

with a coefficient of multiple determination of .51. The commercial bank and System holdings variables had the proper signs but holdings of the international sector had a large positive coefficient. The positive coefficient is no doubt caused by the strong positive trend in the holdings of this sector and the positive trend of the bill rate. The coefficient for System holdings was smaller than its standard error.

The same variables were used for the same time period and dummy monthly seasonal variables were added. This resulted in:

$$(9'')\quad r_b = \underset{(.042)}{-.152C_b} - \underset{(.072)}{.043S} + \underset{(.040)}{.436I} + \underset{\underline{2}}{.994i} + \underset{\underline{6}}{.805ii} + \underset{\underline{11}}{.601iii}$$

$$+ \underset{\underline{7}}{.745iv} + \underset{\underline{10}}{.618v} + \underset{\underline{12}}{.563vi} + \underset{\underline{9}}{.671vii} + \underset{\underline{8}}{.723viii} + \underset{\underline{5}}{.887ix}$$

$$+ \underset{\underline{4}}{.897x} + \underset{\underline{3}}{.959xi} + \underset{\underline{1}}{1.160xii},$$

a coefficient of multiple determination of .55 and a Durbin-Watson statistic of only .15 indicating highly significant positive autocorrelation of residuals. The partial regression coefficients and standard errors are basically the same as those of equation 8". The coefficients for the dummy seasonal variables indicate again that December is the seasonal high for the bill rate with the months September through January generally larger than those months February through August.

The strong positive trend in the quantity of bills over the period 1953-1964 requires that holdings by sectors increase. To obtain the negative partial coefficients for C_b and S, the partial coefficient of I must be positive and large. In order to eliminate the biases due to bill quantity increases, the sector holdings variables were expressed as percentage of bills in the hands of the public, and holdings of non-financial corporations, state and local governments, dealer positions and dealer transactions were added. System holdings were expressed as the percentage of the quantity of bills issued by the Treasury; dealer positions and transactions are utilized as levels instead of as percentages. The results of this equation, with 48 observations from January, 1960 through December, 1964 were:

$$(10'') \quad r_b = 4.059 - \underset{(2.127)}{5.729} C_b/q_b + \underset{(3.823)}{4.929} S/Q_b - \underset{(3.426)}{8.306} I/q_b$$

$$- \underset{(3.203)}{5.422} B/q_b + \underset{(4.436)}{6.631} G/q_b + \underset{(.089)}{.239} D + \underset{(.304)}{.612} V$$

with a coefficient of multiple determination of .74, and a Durbin-Watson value of .60 which indicates a very high probability of positively autocorrelated residuals. With most of the variables expressed as percentages of bill quantities, the partial coefficients for holdings of commercial banks, international government and non-financial corporations were of the expected sign; while System holdings, state and local government holdings, and dealer positions had signs opposite expectations.

Eight independent variables with 48 observations leaves 39 degrees of freedom, but the additional dummy seasonal variables would reduce the degrees of freedom to 28. A greater number of observations would be desirable, but an equation utilizing the variables in 10" plus eleven dummy seasonal variables resulted in:

$$(11'')\quad r_b = -\underset{(1.558)}{5.312}C_b/q_b + \underset{(3.066)}{5.457}S/Q_b - \underset{(2.870)}{2.565}I/q_b - \underset{(3.167)}{1.360}B/q_b$$

$$+ \underset{(4.905)}{2.032}G/q_b - \underset{(.061)}{.074}D + \underset{(.011)}{.075}V + \underset{\underline{4}}{1.203}i + \underset{\underline{9}}{1.071}ii$$

$$+ \underset{\underline{11}}{1.020}iii + \underset{\underline{10}}{1.041}iv + \underset{\underline{12}}{.954}v + \underset{\underline{6}}{1.174}vi + \underset{\underline{2}}{1.236}vii$$

$$+ \underset{\underline{8}}{1.125}viii + \underset{\underline{3}}{1.222}ix + \underset{\underline{7}}{1.160}x + \underset{\underline{5}}{1.191}xi + \underset{\underline{1}}{1.335}xii$$

with an R^2 of .95 and a Durbin-Watson statistic of .90. The Durbin-Watson statistic indicates a very high probability of positively autocorrelated residuals. The constants, or the coefficients for the dummy variables, are smaller in equation 11", ranging from 195 for May to 1.34 for December, than the constant of 4.059 in equation 10". The signs of the partial regression coefficients in equation 11" are negative with the exception of System holdings and state and local governments. Several of the coefficients, however, are only slightly larger than the standard errors, with the state and local government coefficient being only about one-half as large as the standard error. This is not surprising given the poor quality of this particular series.

It is felt that if better data were available for longer time periods much more meaningful results would be possible. Ideally, a structural model should be constructed, but without better data, there is little hope of obtaining meaningful estimates of the parameters.

Summary and Conclusions

This portion of the study has attempted to explain bill rate movements from the point of view of demand for bills by institutional sectors. The attempt at explanation has been complicated because of unavailability of consistent bill holdings data for several sectors over the period.

Since complete data were available for member commercial banks, and also since it is believed that this sector is one of the most important demanders of bills, an attempt was made to explain the level of bank holding of bills. The empirical estimates, using various combinations of free reserves, Treasury deposits, bill rates, and System rediscount rates, generally yielded poor results. A tentative conclusion is that free reserves appear to be highly related to bill holdings.

Data on holdings of bills and Certificates for the international sector are available for the complete period, but are not very volatile, showing instead a strong positive trend and no seasonality. Over the complete period the increased holdings of the international sector have contributed to higher bill rates, but the holdings of this sector have not played a very important role in short-term bill rate movements.

With the exception of bill holdings of the Federal Reserve System and member commercial banks, and the bill and Certificate holdings of the international sector, holdings data for other institutional classifications are available, on a sample basis, generally for the period since 1960 or 1961. Therefore, it is not possible to relate bill rate movements with changes in holdings by all sectors over the complete period. In order to gain some insight into the short-term movements of the bill rate brought about from the demand side, the seasonality of holdings by the various sectors was estimated and the seasonal factors compared with the bill rate seasonal factors to see which sectors might account for a portion of bill rate seasonality.

Finally, the holdings data for the various sectors were used as independent variables in "explaining" bill rate movements. The regression coefficients were usually of the sign expected, but there are indications that the estimates are biased by strong positive autocorrelation of the residuals.

The study of the "demand" factors has been incomplete and basically descriptive. Until a longer series of more accurate holdings data become available, not much can be done to measure the effect of demand shifts on short-term movements in the bill rate.

CHAPTER IX

SUMMARY, CONCLUSIONS, AND SUGGESTIONS FOR FURTHER RESEARCH

This study has emphasized an analytical and empirical approach in attempting to explain the determinants of the average monthly Treasury bill rate over the period 1953-1964. The basic theoretical structure utilized was the schedule measuring the demand to hold Treasury bills at various rates, and the stock of bills as determined by Treasury and Federal Reserve System debt management operations. The hypotheses were developed from partial-equilibrium, comparative-static assumptions, with shifts in the demand schedule having an inverse relationship with the bill rate, and stock changes being positively associated with bill rate movements.

The monthly movements of the bill rate were shown to possess a definite seasonal pattern, although the pattern was changing over time. The X-10 version of Census Method II was used to measure the seasonality of the bill rate, first on a monthly basis, then on a weekly basis. It appeared that the monthly seasonal movements in the rate were probably an average of within month seasonal variations. Over the time period 1953-1964, the bill rate showed a positive trend and a great degree of volatility, complicating the measurement of the seasonal factors.

In order to examine the movements of the rate on a single asset, it is necessary to assume that the factors determining a particular rate are different from factors determining other rates--or more technically that the particular asset is not perfectly substitutable with a relatively large quantity of other assets. The bill rate was correlated with the rate on several other maturity categories of Federal marketable debt, leading to the conclusion that the longer the term to maturity of Federal marketable securities, the less the degree of substitutability with bills. This conclusion, however, ignores the "expectational" hypotheses of interest rate determination which, since it states generally that long-term rates are dependent on future expected short-term rates over the life of the long-term asset, does not necessitate equality of rates for perfect substitutability between longs and shorts.

There was no attempt in the empirical portion of the study to include any variable to measure expectations, principally because of the difficulties involved of finding a suitable variable. If such a variable were included, it is expected that it should influence the bill rate through shifting the demand schedule. An "expectations" variable probably would significantly improve the quality of the empirical relationships.

According to the "pure" expectational hypotheses, the quantity of a security available should have no effect on the market yield of that security. According to the empirical estimates made in the study the quantity of bills does indeed appear to be positively related to the bill rate, as expected from the theoretical framework. The quantity of non-bill Federal marketable debt available to the public also influenced the bill rate in a positive direction, but to a lesser degree than the quantity of bills, indicating a cross elasticity of demand between Treasury bills and close substitutes. Also, the average maturity of the Federal marketable debt was negatively related with the Treasury bill rate indicating that the greater the quantity of short-term Federal marketable debt relative to long-term, the higher the bill rate. The bill rate was generally negatively related to the quantity of bills held by the Federal Reserve System, but the standard error of this coefficient relative to the coefficient in the multiple regression equations was usually large, and the partial regression coefficient was occasionally of the wrong sign.

The principal statistical problems encountered in regressing the monthly bill rate as the dependent variable on quantity-of-debt variables were those of autocorrelation and specification. None of the empirical equations was adequate in explaining bill rate movements. Important explanatory variables, for instance expectations, were missing, and although many variables were entered in trial and error fashion, a high degree of autocorrelation of the residuals resulted. Utilization of successive differences of the variables reduced the problem of autocorrelated residuals, but the estimated equations explained a very small portion of the total variation in monthly changes in the bill rate.

Free reserves of member banks were included as an independent variable along with the quantity-of-debt variables principally to avoid spurious relationships between the bill rate and quantity variables. The free reserves variable was highly inversely related to the bill rate, as hypothesized, indicating that the "demand" variables were probably much more important in explaining bill rate movements than the quantity of bills, the quantity of non-bill marketable Federal debt, System holdings of bills, and the average maturity of the Federal marketable Federal debt. Dividing member bank free reserves into country bank free reserves and free reserves of non-country banks increased the portion of the variance in the bill rate which could be explained by the regression equations. The regression equations emphasizing the quantity-of-debt variables indicated that Treasury debt management operations and System open market operations did directly influence the level of the bill rate, but very large operations would be necessary to appreciably influence the rate. Evidently the demand to hold schedule is highly elastic relative to the bill rate. "Operation Nudge," attempting to raise the short-term rate by increasing the quantity of short-term debt outstanding, appears to have been successful, but according to the empirical estimates presented above, some of the upward movement of the bill rate since 1961-1962 must have been brought about by demand factors. A possible demand variable which could have been influential in a relative decrease in demand for bills is the innovation and rapid acceptance of the negotiable certificate of deposit.

The success of the free reserves variable in explaining bill rate changes led to the assumption that commercial bank demand for Treasury bills might be the most important variable in explaining bill rate changes. An attempt was made to explain the level of holdings of bills by member commercial banks utilizing free reserves of country banks, free reserves of non-country banks, Treasury deposits in commercial banks, and the bill and discount rate. This attempt was not as successful as had been anticipated. It is felt that an explanation of the determinants of bill holdings by commercial banks would necessitate a structural model of a high degree of sophistication. Nevertheless, the algebraic signs were appropriate indicating increases in free reserves, Treasury deposits, and the bill rate were positively related to commercial bank holding of Treasury bills.

Although it appeared that changes in demand for bills by various institutional sectors should explain more of the variance in the bill rate than changes in the stock of bills, bill holding data for most of the institutional sectors is unavailable prior to 1961 and the data for several sectors since 1961 is based on surveys and inadequate for obtaining meaningful results with short time periods. Therefore, the seasonality of holdings of bills by: member commercial banks, the Federal Reserve System, non-financial corporations, state and local governments; transactions and holdings of less-than-one-year maturities by Government securities dealers; and the quantity of bills outstanding was measured by the ratio-to-twelve-month-moving-average method and the resulting seasonal factors compared to the seasonal factors calculated for the bill rate. It seems very feasible that the seasonality in holdings by sectors and the seasonality in the quantity of bills could be responsible for the seasonality of the bill rate.

Multiple regression equations were estimated for the period 1961 through 1964 regressing the bill rate on sector holdings. The results of these estimates, in spite of the shortcomings of the data, show that changes in bill holdings by institutional sectors affect the bill rate according to expectations from the simple stock model. The addition of dummy seasonal variables improved the estimates of the bill rate in the "demand" equations, as they had assisted earlier in the "supply" equations.

The principal hypotheses tested, which received some degree of empirical support, were: (1) the bill market can be analyzed in partial equilibrium and the demand for bills is relatively independent of the demand for other securities of equal risk, (2) the bill rate is affected by changes in the quantity of bills made available by the Treasury and monetary authorities, (3) the bill rate is affected by the demand for bills, and (4) the bill rate movements are predictable (at least in direction) from changes in "institutional" variables, ignoring "expectations." With the exception of the measurement of the seasonality of the bill rate, much of the empirical work in this study should be viewed as exploratory and many of the conclusions tentative. On the basis of the empirical results, it should be feasible to construct different hypotheses in such a way that the statistical tests are more specific. Also, as additional sector bill holding data becomes available it should be possible to estimate more directly the effect on the bill rate of demand changes.

Ideally, an econometric model measuring the simultaneous effects of both the "demand" and "supply" side should be formulated and estimated. This may necessitate tying the Treasury bill market more closely to a macroeconomic, general-equilibrium model. Surely the level of aggregate economic activity is important to the determination of the Treasury bill rate, but the shortest time periods for observations of relevant macroeconomic variables are quarterly, and it seems obvious that many bill rate determinants are effective, important, and interesting over shorter periods--at least monthly, probably weekly, and possibly daily.

Several variables which were not included in the empirical estimates which may improve the relationships are: debits to demand deposits or the turnover rate of demand deposits, a measure of the money supply more meaningful than the simple level, the quantities of other maturity categories of marketable Federal debt, a measure of the average maturity of the Federal marketable debt <u>in the hands of the public</u>, a meaningful measure of expectations of the future course of rates, and a measure of idle balances. Some estimates of changes in holdings of total Federal marketable debt by institutional sectors may be helpful in gaining usable data for the demand by sectors.

Several topics discussed briefly in this study deserve analysis in greater depth. These topics include:

1. Transactions costs for buying and selling bills, stated and effective spreads between the bid and asked prices, and holding period yields on bills after adjusting for transactions cost;
2. The determinants of the "stop-out" price in the primary market and determinants of the spread between the mean of the accepted bids and the low accepted bid;
3. The determinants of the term structure of Treasury bill yields;
4. The determinants of weekly seasonality in the bill rate;
5. The relationship between the bill rate and yields on substitutable assets with equal and greater risk;
6. The determinants of bill holdings by commercial banks; and
7. The reasons for the high degree of relationship between the bill rate and the level of member bank free reserves.

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