A Reexamination of the Relationship Between Liquidity Premiums and the Level of Interest Rates

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This study examines the evidence regarding two competing hypotheses on how liquidity premiums vary with the level of interest rates. A linear model is constructed to test the money substitutes hypothesis and the price risk hypothesis in an attempt to explain liquidity premiums on U.S. Treasury bills over the 1976-1989 period. The results suggest a negative relationship between liquidity premiums and levels of market interest rates in periods characterized by below normal rates and a positive liquidity premium rate level relationship in periods characterized by above normal interest rates. On balance, the price-risk effect appears to be most influential in shaping liquidity premiums when interest rates are below normal, while the money substitutes hypothesis appears to exert a greater influence when interest rates are above normal.

INTRODUCTION

Two competing theories exist on how liquidity premiums[1] vary with the level of interest rates. Kessel (1965) argues that supply and demand conditions with respect to short-term and long-term securities are altered by the changing opportunity costs of holding money as reflected in the current level of market interest rates. More specifically, the lower price risk of short-term bonds makes them better money substitutes than long-term bonds, so investors shift their money holdings to short-term bonds as interest rates rise. The augmented demand for short-term securities causes short-term yields to fall relative to long-term yields so that a liquidity premium appears on longer-term securities, independent of any expectations concerning interest rate movements. Therefore, liquidity premiums (if they exist) may be related directly to the level of interest rates—a proposition known in the literature as the money substitutes hypothesis (MSH).

Alternatively, Van Horne (1965) advocates an inverse relationship between liquidity premiums and the level of interest rates due to the presumed greater liquidity of short-term

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[1] According to Hicks (1946) and others, liquidity premiums are embedded in longer-term interest rates. Such premiums arise both due to the desire of borrowers to seek long-term debt finance and thereby avoid refinancing risks as well as the desire of investors to lend short in order to reduce the variability of investment values. As such, forward rates are biased estimators of future interest rates. Liquidity premiums presumably increase as the term-to-maturity of bonds increases, though not necessarily in strictly proportional terms.

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securities. Fluctuations in bond prices due to changes in the level of interest rates result in risk of loss in the principal value (price) of a bondholder's investment. When interest rates are below (above) normal and are expected to rise (fall), a positive (negative) liquidity premium occurs that reflects potential losses (gains) in value for risk-averse investors. Thus, as Cagan (1969) has observed, the liquidity premium represents the marginal advantage to an investor of holding a security possessing greater liquidity. This view implicitly assumes that interest rates tend to gravitate toward some normal level whenever market interest rates rise above or below that level—a proposition termed the price risk hypothesis (PRH).

Unfortunately, the available empirical evidence regarding these two fundamental hypotheses is mixed. Studies by Kessel (1965), Cagan (1969), and Kane (1983) report evidence in support of the money substitutes hypothesis, while Van Horne (1965) finds evidence consistent with the price risk hypothesis. Both McCulloch (1975) and Olsen (1974) find no significant relationship between calculated liquidity premiums and market interest rates. As Van Horne (1984, p. 132) notes, whether or not liquidity premiums vary with the level of interest rates is an inconclusive topic, because some evidence is consistent with an inverse relationship, whereas other evidence is consistent with a direct relationship. (See also Startz, 1982.) Of these studies, Kane, Van Horne, McCulloch, and Olsen measure liquidity premiums by taking the difference between forward rates and expected future spot rates, while Kessel and Cagan use the difference between holding period yields on bonds of unequal maturities. Cox, Ingersoll, and Ross (1981) have shown that these two definitions of liquidity premiums are not theoretically identical. They prove that using the difference between holding period yields on bonds with unequal maturities provides a better measure of liquidity premiums. Thus, the present study reexamines the relationship between liquidity premiums and the level of interest rates using an empirical approach similar to Cagan's earlier analysis.

In Cagan's study, average weekly liquidity premiums on a quarterly basis for the period 1951 to 1965 are regressed on the following independent variables:

- The quarterly change in the three month Treasury bill rate; the level of interest rates as measured by the quarterly average of monthly data;
- The relative supply of bills proxied by the quarterly average of weekly differences between 13 week bills and one week bills held by the public as a percentage of midquarter total bills held; and
- The deviation of interest rates from normal, approximated by the quarterly average on monthly data for the three month bill rate minus the weighted average of past rates for nine quarters (using linearly declining weights).

Cagan finds that the quarterly change in the level of interest rates is positively and significantly related to liquidity premiums, with no significance detected in the other variables. He argues that the significant relationship between the level of interest rates and liquidity premiums implies that investors prefer short-term T-bills as a substitute for money when interest rates are increasing, which is consistent with the money substitutes hypothesis.

We modify and expand Cagan's analysis and methodology in the following ways. First, we drop Cagan's change-in-rates variable due to the fact that it and the liquidity premium are related by construction rather than by theoretical linkages. Second, weekly calculations of three month liquidity premiums are used in order to increase the number of observations rather than restrict the analysis to quarterly observations. Third, we add the volatility of interest rates as another possible discriminator between the price risk hypothesis and the money substitutes hypothesis. Fourth, because larger numbers of observations are available, data for the sample period are divided into three separate subperiods, thus enabling observation of the stability of results over time. Finally, each subperiod is divided further into below normal and above normal interest rate segments. In so doing, the stability of relationships during different phases of the interest rate cycle are compared.

Our regression analyses suggest that the price risk hypothesis is more applicable to below normal interest rate periods and that the money substitutes hypothesis is more salient during above normal interest rate periods. These results help reconcile the price risk hypothesis and money substitutes hypothesis and provide a plausible explanation of investor behavior. Namely, when interest rates fall below normal, investors are particularly sensitive to price risk from potential increases in rates. On the other hand, when interest rates rise above normal, the money substitutes effect may become the dominant factor, as investors facing high opportunity costs of holding money shift into short-term, interest-bearing securities. Thus, both liquidity premium hypotheses receive some support in this study, depending on whether or not interest rate levels are below or above the normal level of market interest rates.

METHODOLOGY

THE MEASUREMENT OF LIQUIDITY PREMIUMS

Earlier studies have tended to focus upon quarterly and monthly observations which may be insensitive to changes in liquidity premiums or may tend to magnify or distort liquidity-premium effects. In contrast, this study focuses on weekly data for auction discount rates on three month and six month Treasury bills (as provided by the Federal Reserve Bank of New York), with bill prices calculated from these discount rates. Assuming a three month holding period, the liquidity premium is determined by the difference in yields between three month and six month bills in week t.[2] This difference is defined by:

(1) $H_{26,t} - H_{13,t} = L_{13,t} - L_{26,t} + e_{26,t} - e_{13,t}$

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[2] The annual, continuously-compounded holding-period yield for a three month bill in week t is:

$H_{13,t} = 4 \ln (100/P_{13,t})$

where:

$P_{13,t}$ = The price of three month bills at the beginning of week t.

The holding period yield for a six month bill in week t is, therefore:

$H_{26,t} = 4 \ln (P_{13,t+13}/P_{26,t})$,

where:

$P_{26,t}$ = The price of six month bills at the beginning of week t; and
$P_{13,t+13}$ = The price of six month bills after three months have elapsed.

In the present study we use the price of three month bills in week t + 13 as a proxy for $P_{13,t+13}$.

where:

$H_{26,t}$ and $H_{13,t}$ = The holding period yields for six month and three month Treasury bills, respectively;

$L_{13,t}$ and $L_{26,t}$ = The nonpecuniary yields for liquidity services during the three month holding period for three month and six month bills, respectively; and

$e_{26,t}$ and $e_{13,t}$ = Errors in expected pecuniary yields, which have expected values of zero.

Notice that the error terms tend to cancel, leaving only the difference in liquidity premiums. Thus, even though the observed error term for any security in a given holding period may be large, this canceling effect tends to reduce bias in estimating liquidity premiums. Because unanticipated changes in interest rates are unlikely to have substantially different price effects on three month as opposed to six month bills, the cancellation effect should cause the difference in error components in equation (1) to have a negligible net effect on estimated liquidity premiums.[3]

INDEPENDENT VARIABLES

Four independent variables are used to explore testable hypotheses concerning the two competing views—the money substitutes and price risk hypotheses—on the causes of liquidity premiums. All variables are calculated on a weekly basis under the assumption of a three month holding period. The first independent variable is the level of interest rates, or BILL, which is proxied by the three month bill rate from week t to week t + 13. Under the money substitutes hypothesis, BILL should have a positive effect on the liquidity premium, as an increase in the level of interest rates results in investors substituting short-term T-bills for cash, which forces short-term rates down and, therefore, increases the difference between short-term yields and long-term yields reflecting the liquidity premium. If the price risk hypothesis argument is correct, the observed relationship between liquidity premiums and BILL should be negative, as the risk of adverse price movements on longer-term securities is greatest when interest rate levels are low (i.e., a subsequent increase in interest rates would cause capital losses).

The second independent variable measures the volatility of interest rates (RISK). We proxy the volatility of interest rates (at time t) by measuring the volatility of interest rates over the previous three months (t – 13 to t).[4] A positive relationship between RISK and liquidity premiums would be consistent with the money substitutes hypothesis because risk-averse investors are lured from cash into bills. If the HPY differences decrease when interest rates are volatile, investors may be taking advantage of price movements consistent with the price risk hypothesis.

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[3] To the extent that changes in expectations differ for three month and six month bills, our estimate of the liquidity premium is in error. Given that yields on the short end of the yield curve tend to move together, this problem does not appear to be serious. By contrast, if a three month bill and a 30 year bond were compared, the difference in changing expectations could be large. Thus, by restricting our analysis to money market instruments, this problem is mitigated to a large degree.

[4] To allow for comparability to the previous literature, we follow the same approach as Cagan and extend his analysis to the more recent period of 1976 through 1989.

In order to test the potential impact of the relative supply of securities, a third independent variable labeled RELSUP is included in the study. Both liquidity premium hypotheses suggest that the relative supplies of securities with different maturities should affect holding period yields and, therefore, will be reflected in estimated liquidity premiums. We proxy the effect of the relative supply of securities by taking the difference between the total of all outstanding three month bills and the total of all six month bills issued and dividing that difference by the total of all three month and six month bills outstanding (RELSUP), as reported in the *U.S. Treasury Bulletin*. A positive regression coefficient is hypothesized under all interest rate environments because an increase in RELSUP represents an increase in supply, which leads to lower prices, higher absolute holding period yields (HPY), and greater HPY differences.

The last independent variable examines the potential impact of one of the most important money substitutes developed for investors during the 1970s and 1980s—shares in money market mutual funds. The weekly volume of money market fund shares outstanding is divided by the outstanding weekly stock of currency and demand deposits issued in the U.S. over the study period to form variable MMMF. Money market mutual fund share account data are from the *Wall Street Journal*, while the volume of weekly currency and demand deposits are derived from uniform data series compiled by the Federal Reserve Board. MMMF attempts to measure potential shifts in money holdings relative to interest-bearing short-term financial instruments as interest rates change and acts as a demand control variable. A negative regression coefficient is hypothesized in all rate environments because increased demand raises security prices and lowers yields as well as differences in holding-period yields, generating a negative sign.[5]

THE REGRESSION MODEL APPLIED

One problem in testing the relationship between interest rate movements and liquidity premiums is the cyclical pattern of interest rates. If observations from more than one interest rate cycle are pooled and the relationship between interest rates and liquidity premiums changes from cycle to cycle, the pooled statistics may indicate that no relationship exists. It is possible that each interest rate cycle is unique, such that the relationship between interest rates and liquidity premiums varies to some degree depending on factors specific to the period under study and the interest rate level in each cycle. Moreover, by examining more than one time period, it is possible to explore the stability of rate-premium relationships over time. Finally, multiple periods of testing provide a greater vol-

[5] Another variable in the Cagan study is the change in three month Treasury bill rates. Cagan includes this variable in his analysis in an effort to take into account errors in expectations. Because of the canceling-out effect discussed in footnote 3, we do not anticipate expectational errors to approach the magnitude that they may have in Cagan's earlier study. Moreover, by its nature, this measure of interest rate movements would tend to be highly correlated with liquidity premiums. As shown in equations (1) and (2), the liquidity premium in week t includes the price of three month bills in week t as well as the price of three month bills in week t + 13. Because the difference between these prices is used in calculating the change in interest rates, it would be inappropriate to include the change in interest rates in the set of independent variables. The high level of significance and dominance of this variable relative to the other independent variables in Cagan's regressions suggests that this problem may have affected his results. If true, tests of hypotheses relating to the foregoing variables may have been obscured, as the significance of other variables was masked by the rate change variable. For these reasons we exclude this variable from the regression analysis.

ume of empirical evidence upon which to draw inferences concerning competing liquidity premium hypotheses.

In the period under study (January 1976 to June 1989) substantial swings in interest rates occurred in response to cyclical economic movements, changes in monetary policy, and other structural factors. In October 1979 the Federal Reserve changed its targets from interest rates to money supply. Subsequent to this change in policy, interest rates rose to unprecedented levels. Also, the volatility of market interest rates increased greatly. Later the Fed gradually changed its operating procedures over the 1982-1984 period to take a more balanced approach to monetary targeting. Indirect evidence of this change is reflected in the relatively lower and generally more stable interest rates prevailing since 1983.

In recognition of these different interest rate cycles and monetary policy regimes, we divide the data for this study into three subperiods:

- January 13, 1976 to February 24, 1979 (n = 168 weeks);
- June 16, 1979 to October 8, 1982 (n = 175 weeks); and
- January 14, 1983 to June 3, 1989 (n = 324 weeks).

A 14 week gap is interposed between these three subperiods to avoid overlapping data, because for each week the variables are calculated with data for the forthcoming three months. The first period tended to have relatively low and stable market interest rates, while the second period encompassed the volatile interest rate period discussed in the preceding paragraph with relatively high levels of market interest rates. The third period is associated with a more balanced approach to monetary policy and a period of relatively rapid economic growth (i.e., recovery from the 1982 recession and the sharp decline of worldwide oil prices occurred) and declining market interest rates.

We further divide the weekly observations within each subperiod into below normal and above normal interest rate segments, relative to the mean market rate for a 52 week period (NORM).[6] The rationale for this division of the data is that both the money-substitutes effect and the price-risk effect may be influencing relative yields on three month and six month bills simultaneously. By comparatively examining the association between liquidity premiums and the independent variables during these two segments, we hope to gain insight into which effect (the money substitutes hypothesis or the price risk hypothesis) is strongest during different phases of the interest rate cycle. Moreover, according to the price risk hypothesis, liquidity premiums and interest rates should be related inversely (both below and above the normal level of interest rates), while the money substitutes hypothesis suggests a direct premium-rate relationship. Dividing the observations into these two segments provides a stronger test of these hypotheses. For instance, if these two interest rate segments are not examined separately, it is possible that an inverse relationship among liquidity premiums and interest rates at lower interest rate levels would be offset by a positive relationship at higher interest rate levels.

The general form of the regression model to be employed is as follows:

$$(2)\ L_t = \hat{b}_0 + \hat{b}_1 BILL_t + \hat{b}_2 RISK_t + \hat{b}_3 RELSUP_t + \hat{b}_4 MMMF_t + e_t$$

[6] NORM is calculated as the ratio of BILL to the average of weekly T-bill rates from t - 52 to t.

where:

L_t = The three month liquidity premium for week t as calculated from equation (1).

Because the independent variables are calculated as three month moving averages on a weekly basis and autocorrelation of the residuals in equation (2) may be expected, the AUTOREG procedure on SAS (1982) is employed to model the autoregressive process of the regression residuals.[7]

EMPIRICAL RESULTS

Table 1 reports the empirical results for the three interest rate periods, where interest rates are characterized as being below normal, above normal, and combined during each interest rate period. The results for the BILL and RISK variables are particularly important in discerning the relative strengths of the money substitutes and price risk hypotheses. When we examine the below normal interest rate subperiods, BILL is significantly negative in two of the three subperiods. Conversely, when we examine the above normal interest rate subperiods, BILL is significantly positive in all three subperiods. These results suggest that the price risk hypothesis has greater applicability to low interest rate periods, whereas the money substitutes hypothesis tends to dominate high interest rate periods. When interest rates are below normal, investors appear to require a rate premium as compensation for price risk. When interest rates are above normal, however, investors shift money holdings into money market instruments due, at least in part, to the higher opportunity cost that exists at that time. This does not mean that price risk does not affect security prices and market interest rates when interest rates are high; rather, the money substitutes argument appears to play a greater role than the price risk factor when market interest rates rise above normal levels.

Table 1—Regression Model Results Across Three Periods of Time[a]

Panel A: Period I	Below	Above	Combined
Intercept	0.76	0.17	0.37
	(4.23*)	(2.61*)	(1.31)
BILL	-0.12	1.29	0.82
	(-3.05*)	(2.67*)	(0.03)
RISK	-2.05	1.07	-0.02
	(3.16*)	(2.68*)	(-0.66)
RELSUP	0.09	0.23	0.15
	(3.73*)	(2.05*)	(2.21*)
MMMF	-1.38	-0.98	-2.14
	(-1.98*)	(-5.63*)	(-0.28)
R^2	0.46	0.37	0.23

[7] Other regression methods that were fitted to the data included Yule-Walker, iterated Yule-Walker, and maximum likelihood. The superior fit obtained by the nonlinear least squares approach is consistent with the nonlinear nature of the term-structure-of-interest rates relationship.

Table 1—Regression Model Results Across Three Periods (cont.)

Panel B: Period 2	Below	Above	Combined
Intercept	-0.11	-1.45	-0.97
	(-1.13)	(-4.45*)	(-0.42)
BILL	-1.68	0.31	-0.02
	(-2.19*)	(1.98*)	(0.73)
RISK	-0.82	5.21	1.21
	(-3.23*)	(4.16*)	(0.63)
RELSUP	2.57	1.19	0.01
	(2.31*)	(1.03)	(0.17)
MMMF	-0.72	1.00	-0.66
	(-3.61*)	(0.57)	(-1.33)
R^2	0.52	0.21	0.18

Panel C: Period 3	Below	Above	Combined
Intercept	0.62	-6.23	1.25
	(1.92)	(-3.67*)	(0.21)
BILL	0.01	0.93	1.24
	(1.15)	(2.41*)	(0.19)
RISK	-1.15	0.29	-0.12
	(-3.48*)	(1.27)	(-0.98)
RELSUP	1.35	-0.61	0.96
	(3.71*)	(2.86*)	(2.48*)
MMMF	-0.12	-6.23	-1.56
	(-2.05*)	(-5.21*)	(3.13*)
R^2	0.25	0.42	0.27

[a] Periods 1, 2, and 3 are, respectively: January 3, 1976 to March 24, 1979; June 16, 1979 to November 8, 1982; and January 14, 1983 to June 30, 1989. Weekly observations within each period are classified as below normal or above normal interest rate levels based on the previous 52 week average of T-bill rates. t-statistics are shown in parentheses

[b] The correlation matrix for these variables using data for all three subperiods is as follows:

	Intercept	BILL	RISK	RELSUP	MMMF
Intercept	1.00	-	-	-	-
BILL	0.28	1.00	-	-	-
RISK	0.31	0.59	1.00	-	-
RELSUP	0.13	0.26	0.36	1.00	-
MMMF	0.10	0.01	0.19	0.11	1.00

The RISK variable is as consistently significant as the BILL variable, with the same pattern of signs. When interest rates are below normal, the RISK variable is related negatively to liquidity premiums in all three below normal rate periods, consistent with the price risk view. In contrast, when interest rates rise above normal, RISK is related positively to the liquidity premium, as suggested by the money substitutes hypothesis, in all three subperiods. Thus, liquidity premiums respond similarly to changes in both the current level of interest rates and the implied risk associated with those rates. The similarity of these patterns in below and above normal interest rate periods tends to strengthen the earlier inferences we made concerning the price risk hypothesis and the money substitutes hypothesis.

By contrast, both BILL and RISK are statistically insignificant when combined historical data cutting across all subperiods are used. Recall that previous researchers have combined data across all periods which may have obscured the apparently segmented relationships between liquidity premiums and interest rates that this study observes. If combined data had been employed exclusively here, we would have found no evidence of a liquidity premium effect. Differentiating below normal and above normal interest rate segments is useful in finding support for the liquidity preference hypothesis.

Finally, we examine the results for the supply and demand control variables, RELSUP, and MMMF. When we examine below normal interest rate subperiods, the RELSUP and MMMF coefficients are positive and negative, respectively, as expected and statistically significant. When we examine the above normal interest rate subperiod, we find similar but weaker results. RELSUP is significantly positive in two of three subperiods, while MMMF is significantly negative in two of three subperiods. In period two, RELSUP and MMMF switch signs. When the data are combined, however, both RELSUP and MMMF have the hypothesized signs.

SUMMARY AND CONCLUSIONS

This study focuses upon two competing hypotheses regarding the linkages between the level of interest rates and liquidity premiums in the term structure of interest rates. The price risk hypothesis contends that liquidity premiums are related negatively to the prevailing level of market interest rates. In contrast, the money substitutes hypothesis argues for a positive relationship between market interest rates and liquidity premiums.

The present study modifies and expands Cagan's earlier analysis of the relationship between liquidity premiums and interest rate levels and, in so doing, provides evidence for liquidity premium relationships not previously reported. Data are divided into three subperiods representing varying stages of the interest rate and business cycle and different monetary policy regimes. Unlike previous studies, data are divided further into below normal and above normal interest rate segments. The interest rate and liquidity variables are calculated weekly under the assumption of a three month holding period in order to generate sufficient sample sizes for the six different regression models tested in this study. By examining the results over different interest rate periods, the stability of the price risk and money substitutes hypotheses over time can be observed. Also, by delineating below normal and above normal interest rate periods, a closer examination of the relative strength of the competing hypotheses can be obtained during different phases of the interest rate cycle.

Our main conclusion is that the price risk hypothesis appears to hold during low interest rate periods, while the money substitutes hypothesis holds when interest rates are high. In this regard, the regression results generally indicate a negative relationship between liquidity premiums and both the current level and the volatility associated with the current level of market interest rates in subperiods characterized by below normal interest rates and a positive relationship in subperiods marked by above normal rates. We interpret these results to imply that price risk is most influential among investors when interest rates are perceived to be below normal. When market rates rise above the perceived normal level, the relatively high opportunity cost of holding money balances tends to motivate the substitution of short-term, interest-bearing securities for money balances. While price risk and money substitution effects, in all likelihood, exist simultaneously and affect relative prices of securities possessing different maturities, the empirical evidence presented here suggests that the dominance of one effect over the other depends upon the current level of interest rates relative to perceived normal levels. Other variables associated with the level of interest rates, including the relative supply of three month and six month bills and the volume of money-market mutual fund assets compared to the public's holdings of currency and demand deposit balances, yield mixed findings regarding the principal hypotheses of this study.

A critical implication of our findings is that the mixed evidence in previous empirical studies on the relationship between liquidity premiums and the level of interest rates can be attributed in part to data aggregation that ignores the different phases of the interest rate cycle. Further study of how liquidity premiums vary with interest rates at different points in the interest rate cycle is recommended using alternative data sources, different time periods, and a variety of linear and nonlinear model specifications.

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