2011

A Test of the Expectations Hypothesis in Very Short-term International Rates in the Presence of Preferred Habitat for Liquidity

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Abstract

This study incorporates year-end and quarter-end preferences for liquidity and other calendar-time effects into the test of the expectations hypothesis (EH) in the very short-term LIBOR (maturities of one month and shorter) in seven major world currencies. The calendar-time effects are found to alter long-term relations between very short-term rates in these currencies. These effects alone are not responsible for the rejection of the EH in the data, as it is rejected in most of cases even after appropriate controls are introduced. However, such effects are capable of causing the EH to be rejected and should be controlled for when testing the EH in very short-term rates.

Keywords: *Expectations Hypothesis, Preferred Habitat for Liquidity, LIBOR*

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1. Introduction

The expectations hypothesis (EH), one of the oldest and most widely tested propositions in economics and finance, states that future expected interest rates are implied by the current term structure. The pure form of the EH posits that the return on holding a long-term bond to maturity should be equal to the expected return on investment in a series of short-term bonds over the life of the long-term bond.[1]

The preferred habitat theory (PH) was proposed by Modigliani and Sutch (1966) to add to the explanation of the term structure. According to the PH, investors who for some reason prefer certain maturities may be induced to invest in other maturities if offered a sufficiently large premium. Ogden (1987) identifies the end of the month and especially the end of the year as a preferred habitat for lenders in the U.S. money markets. He reports that a disproportionately large share of cash obligations (e.g., interest and dividend payments, year-end bonuses) is scheduled around month-ends. Griffiths and Winters (1997, 2005) find abnormally high rates prior to the year-end in U.S. money market instruments; the rates start declining to "normal" levels prior to the year-end. This pattern is consistent with a year-end being PH for lenders suggested by Ogden (1987). Investors who have cash obligations to pay prior to the end of a year would prefer to invest in money market securities that mature prior to their cash obligation dates (which do not have to align precisely with the last day of the year). Griffiths and Winters (1997, 2005) dub this effect a *preferred habitat for liquidity*. Kotomin, Smith, and Winters (2008) test for year-end and quarter-end effects in short-term LIBOR in eleven currencies and find patterns consistent with the year-end PH for liquidity in the

[1] This statement is true in the case of certainty. For uncertain interest rates, deviations between long- and short-bond returns should follow a zero-mean white noise process. The pure EH assumes risk-neutral investors, who require no premium when investing in a long-term bond. If investors are risk averse and thus prefer the less risky short-term securities, the pure EH does not hold. Investors can still be induced to hold longer-term, more risky securities if offered extra yield (a term premium). The term premium for a given maturity must be constant for the EH to hold.

one-week and one-month LIBOR for the world's major currencies – the U.S. Dollar, the Euro, the Japanese Yen, and the Swiss Franc. The one-week and one-month LIBOR yields increase significantly two days before the maturity of the loan starts to span the end of the year and returns to normal levels starting on the third-to-last trading day of the year.

This study builds on the findings of Kotomin, Smith, and Winters (2008) and tests whether the expectations hypothesis holds when the PH for liquidity is controlled for. I use overnight LIBOR as a short-term rate, and one-week, two-week, and one-month LIBOR as long-term rates. If investors' preference for year-end liquidity manifests itself in abnormally high long rates prior to the end of the year, the long-term relation between long and short rates is temporarily distorted. This distortion may lead to a rejection of the EH at the short end of the term structure, such as in Downing and Oliner (2007), who find that the EH is rejected before but not after controlling for the year-end increase in commercial paper yields in the U.S. This study confirms that the PH for liquidity and other calendar-time effects certainly alter the relations between very short-term rates in the world's major currencies. The EH is still rejected in most cases after the year-end and quarter-end PH for liquidity and other controls are introduced. Regression fit improves in every case after introducing these controls, and the estimated coefficients of the PH for liquidity variables are significant for the majority of interest rate pairs. It is clear that the PH effects impact the relations between short and long rates in some of the major world currencies. These effects should be controlled for when testing the EH at the short end of the term structure.

2. Background and Hypotheses

The EH implies that a long-term rate equals an average short-term rate over the lifespan of a long-term rate plus a constant term premium. A common parameterization used to test the EH is

$$\frac{1}{k}\sum_{t}^{t+k-1} r_t^{\,m} - r_t^{\,n} = a_0 + \beta_1 r_t^{\,n} + \varepsilon_t \qquad (1),$$

where r^m is the short (m-period) rate, r^n is the long (n-period) rate, and k = n/m is an integer. The intercept is a term premium, which must be statistically equal to zero for the pure form of the EH to hold. The slope coefficient must not be different from zero for the EH to hold; that is, the level of the long rate must not have predictive power for the spread between the average short rate and the long rate. Another frequently used parameterization is

$$\frac{1}{k}\sum_{t}^{t+k-1} r^{m} - r_t^{m} = a_0 + \beta_1 (r_t^{n} - r_t^{m}) + \varepsilon_t \qquad (2).$$

If the EH holds, beta in (2) will be indistinguishable from one; that is, the spread between the long and short rates will not have predictive power for the future short-term rate behavior. If the pure form of the EH holds, the intercept must be statistically equal to zero in addition to beta being statistically indistinguishable from one.

Numerous empirical tests of the EH have been undertaken. Overall, they have rejected the EH more often than they have failed to do so, especially at the short end of the term structure. The most widely discussed explanations of the EH failure are time-varying term premia, irrationality of market participants, and overreaction of market participants to monetary policy changes.[2] Longstaff (2000) is a notable exception. He tests the EH using (1) and finds that pure expectations hold in the term structure of U.S. repurchase agreement (repo) rates over the period May 21, 1991 through October 15, 1999. In his study, an overnight repo rate is the short rate, while term repo rates are the long rates. Brown, Cyree, Griffiths, and Winters (Brown et al., 2008) reexamine the finding of Longstaff (2000) because they find it surprising that the EH holds in the market known

[2] E.g., Campbell and Shiller (1991), Cook and Hahn (1990), Fisher and Gilles (1998), Tzavalis and Wickens (1997).

to have a year-end increase in term repo rates consistent with PH for liquidity (Griffiths and Winters 1997). Brown et al. (2008) conclude that Longstaff's results are sample-specific as the EH does not hold in out-of-sample data (relative to the Longstaff's sample) even after controlling for preferred habitat effects.[3]

Downing and Oliner (2007) test the EH in the U.S. commercial paper (CP) market using an overnight CP rate as a short rate. The CP market is characterized by large yield increases in term CP (maturities longer than overnight) at the end of the year related to preferred habitat for liquidity (Griffiths and Winters 2005). While Downing and Oliner (2007) do not attribute this yield behavior to the year-end PH for liquidity, they find the results are more supportive of the EH when they control for the year-end yield increases. The dealer-quoted data collected prior to 1998, however, reject the EH even after controlling for the year-end effect.

This study examines whether the PH for liquidity-related year-end and quarter-end increases in short-term LIBOR (maturities between one week and one month) for major world currencies identified by Kotomin, Smith, and Winters (2008) are responsible for the rejection of the EH when overnight LIBOR is the short-term rate.[4]

Among the three common explanations of the EH failure – time-varying risk premia, irrationality of market participants, and overreaction to monetary policy changes – the phenomenon studied herein is clearly related to the time-varying premia since calendar-time liquidity preferences are rational and do not arise in response to monetary policy changes. When the spread between long and short rates changes prior to the end of the year or quarter due to investors' liquidity preferences, the EH may be rejected because of this temporary (and regular) distortion to the long-run relation

[3] Della Corte, Sarno, and Thornton (2008) also re-examine Longstaff (2000) using different methods and find that the EH is rejected in the term structure of repo rates but departures from the EH are not economically significant.
[4] I refer to the end of the fourth quarter as the year-end, and to ends of the first three quarters as quarter-ends hereafter.

between the rates. To my knowledge, Brown et al. (2008) and Downing and Oliner (2007) are the only studies that test the EH while controlling calendar-time effects in short-term interest rates. Given their findings, the year-end and quarter-end PH for liquidity may or may not cause the expectations hypothesis to be rejected at the short end of the term structure. I hypothesize that the EH will be rejected in the currencies with identified year-end and quarter-end yield changes when these changes are not controlled for and may not be rejected when they are.

3. Data

The data represent daily fixings of the London Interbank Offer Rate (LIBOR) by the British Bankers Association (BBA). Longstaff (2000), Brown et al. (2008), and Downing and Oliner (2007) all employ a one-day (overnight) rate as a short rate in their tests of the EH. I test the EH using overnight LIBOR as the short rate and one-week, two-week, and one-month LIBOR as long rates. Overnight LIBOR data are available from the beginning of 2001 for the following seven currencies: U.S. Dollar (USD), Pound Sterling (GBP), Euro, Japanese Yen (JPY), Swiss Franc (CHF), Australian Dollar (AUD), and Canadian Dollar (CAD). I chose the sample period to end on April 30, 2007, due to the global financial crisis that started affecting the money markets in the summer of 2007 and led to extremely high volatility in short-term rates over the next two years.

BBA LIBOR is the primary benchmark for short-term interest rates globally and is used as the basis for settlement of interest rate contracts on many of the world's major futures and options exchanges as well as many over-the-counter (OTC) and lending transactions.[5] Kotomin, Smith, and Winters (2008) find that one-week and one-month LIBOR in U.S. Dollar (USD), Japanese Yen

[5] BBA LIBOR is the British Bankers Association's fixing of the London Inter-Bank Offered Rate. It is based on offered interbank deposit rates provided in accordance with the instructions to BBA LIBOR Contributor Banks. For a complete description of LIBOR, see the BBA LIBOR web site at http://www.bbalibor.com.

(JPY), Euro (EURO), and Swiss Franc (CHF) have a pronounced year-end effect and a smaller quarter-end effect consistent with preferred habitat for liquidity. In particular, the one-week and one-month LIBOR spreads over longer-term LIBOR in these currencies increase two days before the loan maturity starts spanning the end of the year (i.e., the second-to-last trading day of November in the case of the one-month maturity) or quarter and stay high through the third-to-last trading day of the year or quarter, after which they start to return to the "normal" levels. Kotomin, Smith, and Winters (2008) do not find such effects in maturities of three months or longer. In this study the overnight LIBOR is the short rate. The long-term rates are one-week, two-week, and one-month LIBOR.[6]

Table 1 reports mean rates and spreads between the longer-term and overnight LIBOR in each of the seven currencies over (i) the entire sample period, (ii) "regular" days (those excluding "year-end" and "quarter-end" periods), (iii) "quarter-ends" periods only, and (iv) "year-ends" periods only. A given day is included in the year-end (quarter-end) period if a loan *originates on or before and matures after* the third-to-last trading day of the year (quarter other than fourth). For example, the year-end period for one-month LIBOR includes the second-to-last trading day of November through the third-to-last trading day of December. For the purposes of constructing Table 1, the year-end and quarter-end periods for the one-day LIBOR are the same as for the one-month LIBOR. The term premia (spreads) are higher prior to the end of the year and, in a few cases, quarter in USD, Euro, JPY, CHF, and CAD. For example, the average spread between two-week and one-day USD LIBOR is 1.4 basis points on "regular" days; it is 3.6 basis points preceding quarter-ends (excluding year-

[6] Kotomin, Smith, and Winters (2008) did not study overnight and two-week LIBOR.

ends) and 11.9 basis points prior to year-ends. AUD is the only currency that does not exhibit noticeable changes in the spreads prior to year- and quarter-ends.[7]

[Insert Table 1 about here]

4. Methods and Empirical Results

4.1 Preliminary Tests

To test whether the year-end and quarter-end spread changes reported in Table 1 are statistically significant, the following OLS with Newey-West standard errors is estimated:

$$r_t^n - r_t^m = \alpha_0 + \alpha_1 YPH + \alpha_2 QPH + c_1 MEnd + c_2 YTurn + c_3 Sept11 + c_4 afterSept11 + \varepsilon_t \qquad (3).$$

YPH (QPH) equals one if an observation date is on or before and maturity date of the loan is after the third-to-last trading day of the year (quarter other than fourth). These indicator variables are designed to cover periods of increased spreads prior to year-ends (quarter-ends) related to preferred habitat for liquidity identified in LIBOR by Kotomin, Smith, and Winters (2008). [8]

MEnd is equal to unity on the last trading day of a month, providing a control for occasional spikes in overnight rates at month-ends (Brown et al., 2008). *YTurn* is the indicator variable that covers the period between December 22 and January 10 of the next year. It can capture possible shifts in term premia at the turn of the year when liquidity appears to be low (Downing and Oliner, 2007). The *Sept11* indicator variable takes the value of one when the observation date is before

[7] Kotomin, Smith, and Winters (2008) find that GBP LIBOR behaves differently from other major currencies. Griffiths, Kotomin, and Winters (2009) point out that December 24 is the effective year-end in the U.K. money markets. Accordingly, the year-end period for GBP starts when a loan *originates on or before and matures after* the third-to-last trading day before December 24. However the year-end period is defined for GBP, the overnight GBP LIBOR increases more than one-week and two-week rates, while the one-month rate falls prior to year-ends. This is different from other currencies in which overnight rates tend to fall relative to term rates prior to year-ends. I do not have an explanation for this rate behavior in GBP.

[8] E.g., in 2003, YPH for the one-month maturity is set to one on each trading day from November 27 through December 29; in Q3of 2005, QPH for the one-week LIBOR covers from September 22 through September 28. The year-end period for GBP starts when a loan *originates on or before and matures after* the third-to-last trading day before *December 24* (see footnote 7).

September 12, 2001 and the maturity date is after September 12. Similarly to the YPH and QPH variables, it covers a different number of days depending on the maturity of the long rate. The variable *afterSept11* equals one when the observation date is between September 12 and September 18, 2001. The reason for the September 11 controls is that the attacks caused major disruptions in the money markets (Downing and Oliner, 2007). [9,10]

Equation (3) tests for year-end and quarter-end effects in the term spreads. The estimated coefficients of YPH (QPH) would be positive in currencies with a year-end (quarter-end) preferred habitat for liquidity. Table 2 reports the estimated coefficients of these variables. The key results are as follows:

- Six out of the seven studied currencies have either year-end effects, quarter-end effects, or both. AUD does not show any significant spread changes prior to quarter-ends and year-ends.
- GBP LIBOR spread behavior is different from other currencies at year-ends. The overnight GBP LIBOR increases more than one-week and two-week rates, while the one-month rate falls prior to year-ends.
- Quarter-end effects weaken as maturity of the long rate increases. E.g., when one-month LIBOR is the long rate, only one QPH parameter (in JPY) is statistically significant. It is consistent with investors starting to prepare for year-ends at least a month in advance, with quarter-end preparations starting closer to the end of the quarter.

[9] BBA LIBOR fixings take place at 11am London time. Therefore, the September 11, 2001 fixing occurred before the terrorist attacks.

[10] Downing and Oliner (2007) use indicator variables to isolate each year-end period as well as a third-degree polynomial to control for the possibility of gradual changes in the term premia as a year-end approaches. Using a model similar to theirs does not result in significant improvements. Therefore, I use a more parsimonious model.

All of these results are consistent with the findings in Kotomin, Smith, and Winters (2008). Having confirmed the existence of year-end and quarter-end preferred habitat effects, I proceed to test the expectations hypothesis with and without controls for preferred habitat for liquidity. [11]

[Insert Table 2 about here]

4.2 The Tests of the Expectations Hypothesis

First, following Downing and Oliner (2007), I test the EH using a modification of (1):

$$r_t^n - \frac{1}{k}\sum_{t}^{t+k-1} r_t^{\,m} = a_0 + \beta_1 (r_t^n - r_t^{\,m}) + \varepsilon_t \qquad (4),$$

where r^m is the short rate (overnight LIBOR), and r^n is the long rate (one-week, two-week, or one-month LIBOR) in a given currency. The beta (the slope of the long-short spread) must not be different from zero for the general form of EH to hold. In addition, the alpha (the term premium) must not be different from zero for the pure form of EH to hold.[12]

Next, I estimate the regressions with variables controlling for preferred habitat for liquidity effects, month-ends (similarly to Brown et al. (2008)), the turn-of-the-year, and the impact of the

[11] I also conducted a series of preliminary tests related to *cointegration:* Granger causality tests, Dickey-Fuller tests, and the estimation of cointegrating vectors using the Johansen (1991) procedure. Cointegration between short and long rates is a necessary condition for the EH to hold in the long run. The Granger causality and Dickey-Fuller tests suggest cointegration between short and long rates within each currency, and cointegrating vectors are close to (1; -1), the theoretical value consistent with the EH holding in the long run, with the exception of JPY. The vectors are statistically indistinguishable from (1; -1) for all but one interest rate pairs in GBP, Euro, CHF, and CAD. In other cases, statistical tests reject the null that the vector is equal to (1; -1) due to small standard errors. When the YPH and QPH variables are included into the estimation of the cointegrating vectors as exogenous variables, the vectors in most cases move closer to (1; -1) but the statistical significance rarely changes. The results are available upon request.

[12] The extent of the small sample bias on the estimates of β in Equation (4) noted by Bekaert, Hodrick, and Marshall (1997) is not known. The sample size (more than 1500 observation) may alleviate this bias.

terrorist attacks of September 11, 2001 (similarly to Downing and Oliner (2007)):

$$r_t^n - \frac{1}{k}\sum_t^{t+k-1} r_t^m = a_0 + \alpha_1 YPH + \alpha_2 QPH + \beta_1(r_t^n - r_t^m) + \beta_2(r_t^n - r_t^m)YPH + \beta_3(r_t^n - r_t^m)QPH$$
$$+ c_1 MEnd + c_2 YTurn + c_3 Sept11 + c_4 afterSept11 + \varepsilon_t \quad (5).$$

Newey-West standard errors are used in estimating Equations (4) and (5), with the number of lags equal to loan maturity in business days (e.g., five for the one-week maturity).

The PH for liquidity may affect both the intercept (alpha) and the slope (beta). The coefficient α_1 (α_2) in Equation (5) measures the differences between the intercept during year-end (quarter-end) periods and the intercept on all other ("regular") days (α_0). The coefficient β_2 (β_3) measures the difference between the slope of the long-short spread during the year-end (quarter-end) period and on "regular" days (β_1). If α_1 (α_2) is not different from zero, year-end (quarter-end) preference for liquidity does not affect the term premium. If β_2 (β_3) is not different from zero, then PH for liquidity does not affect the slope of the long-short spread. If all four coefficients are not different from zero, PH for liquidity does not affect the relation between the overnight rate and a given longer rate in a given currency.

The remaining independent variables are the controls first introduced in Equation (3).

Finally, I follow Brown et al. (2008) and run an ARCH-M model suggested by Engle, Lilien, and Robins (1987). The mean equation is:

$$r_t^n - \frac{1}{k}\sum_t^{t+k-1} r_t^m = a_0 + \alpha_1 YPH + \alpha_2 QPH + \beta_1(r_t^n - r_t^m) + \beta_2(r_t^n - r_t^m)YPH + \beta_3(r_t^n - r_t^m)QPH$$
$$+ c_1 MEnd + c_2 YTurn + c_3 Sept11 + c_4 afterSept11 + \delta \log(h_t) + \varepsilon_t \quad (6),$$

and the variance-in-the-mean equation is:

$$h_t = \mu + \lambda\varepsilon_{t-1}^2 + \gamma_1 YPH + \gamma_2 QPH + \gamma_3 MEnd + \gamma_4 YTurn + \gamma_5 Sept11 + \gamma_6 afterSept11 \quad (7).$$

This specification allows for a variance in the mean equation, which helps control for the effect of errors if the average short rate is far from the long rate.[13]

Controlling for PH for liquidity and other effects may lead to changes in the estimated intercept and slope coefficients. Table 3 contains the estimated coefficients of the key variables from Equations (4), (5), and (6). Below is the summary of important results evident from Table 3.

First, the OLS with controls (Equation 5) always fits the data better than the basic model (Equation 4), based on comparisons of the reported R-squareds and Akaike Information Criteria (AIC's). The basic model has insignificant F-statistics on several occasions, while the OLS with controls is always significant (the F-stats are not reported).The ARCH-M model always fits the data better than either of the OLS specifications (based on comparisons of the AIC's). This result implies that calendar-time effects should be controlled for and that non-linear models may be preferred to linear ones when testing the EH at the short end of the term structure.

Second, after the control variables are introduced *or* when the non-linear model is used, the intercept on the days outside of year- and quarter-ends (α_0) becomes indistinguishable from zero for the following seven of the 21 rate pairs (the long rates are specified): one-week and two-week USD, two-week and one-month Euro, two-week JPY, two-week CHF, and one-week CAD LIBOR. In these seven cases, α_0 becomes consistent with the pure form of EH. The opposite – α_0 becoming significantly different from zero after switching to more advanced models – happens only once (one-week Euro LIBOR). At least one of the coefficients of the YPH and QPH variables (α_1 and α_2) is

[13] As Brown et al. (2008) note, this model has performed well in controlling for ARCH effects in prior term structure research. Different model specifications, e.g., with more ARCH terms or with GARCH terms, result in a qualitatively similar output.

statistically significant in the majority of interest rate pairs. This finding suggests that calendar-time effects affect the relations between interest rates and therefore may cause the rejection of the EH.

Third, after the control variables are introduced *or* when the non-linear model is used, the key slope coefficient (β_1) remains consistent with the significance levels in the model without control variables for ten out of 21 rate pairs, becomes statistically significant for nine of them, and becomes insignificant in only two cases. The slope of the long-short spread becoming statistically significant represents movement toward rejection of the EH. At the same time, the coefficients of the spread during year-end and quarter-end periods (β_2 and β_3) are statistically significant for the majority of the interest rate pairs. The long-short spread slope coefficient (β_1) becoming statistically significant when more advanced models are used is likely the result of the improved model fit.

[Insert Table 3 about here]

Overall, it is clear that calendar-time effects, such as year-end and quarter-end preferences for liquidity at the short end of the yield curve, are not solely responsible for the rejection of the EH in the data but they alter long-run relations between interest rates and *may* cause the EH to be rejected.[14,15,16]

[14] I also ran a variety of tests of the EH over much longer time periods (varying by currency) using the one-month LIBOR as the short rate and three-month, six-month, or twelve-month LIBOR in the same currency as the long rate. In these tests, the short rates would have identified calendar-time preferred habitat effects, and the long rates would not. The results are qualitatively similar to those reported in the paper in that the EH tends to be rejected.
[15] Using Equation (2) as the base for the tests instead of Equation (4) results in the output equivalent to that reported in Table 3.
[16] As a supplementary test, I ran error-correction models for each pair of rates to see how soon the rates return to long-term equilibrium between them. Daily adjustments in most currencies are less than 50% (in many cases much less) of the previous day's deviation from the long-term equilibrium. Such adjustments may be too slow for the EH to hold in the short run. When YPH, QPH, and the other controls are used in the error-correction models as exogenous variables, the estimated speed of adjustment increases slightly for most of interest rate pairs but remains very far from 100%.

5. Conclusion

Empirical studies often reject the expectations hypothesis (EH), especially at the short end of the term structure. There are several possible reasons for this rejection: time-varying risk premia, irrationality of market participants causing failure of rational expectations, and overreaction of market participants to monetary policy changes. This study incorporates the effect of investors' preference for liquidity prior to the end of the year or quarter and other calendar-time effects into the tests of the EH in very short-term LIBOR for major world currencies. Kotomin, Smith, and Winters (2008) find that the year-end and quarter-end preferences for liquidity manifest themselves in international money markets in an increase in the one-week, two-week, and one-month LIBOR for some of the major world currencies. Because this increase temporarily distorts the long-run equilibrium relations between interest rates of different maturities, it may contribute to the failure of the EH at the short end of the term structure.

The results of this study suggest that, although the year-end and quarter-end preferences for liquidity affect one-week, two-week, and one-month LIBOR in major world currencies – USD, Euro, CHF, JPY, and CAD – they are not solely responsible for the rejection of the EH in the short run. The EH is rejected for the majority of interest rate pairs. Introducing controls for year-end and quarter-end effects consistent with preferred habitat for liquidity and other calendar-time controls always improves the model fit and often causes the term premium (alpha) to become indistinguishable from zero, consistent with the EH. However, the long-short spread slope does not become more consistent with the EH, leading to its rejection in most of the cases. Overall, the PH for liquidity and other calendar-time effects appear to alter the relations between rates of different short-term maturities in major world currencies and may be capable of causing the rejection of the EH.

The implication for future research is that such effects must be controlled for when testing the EH in very short-term rates.

Acknowledgments

I thank Drew Winters of Texas Tech University and the two anonymous referees for helpful comments.

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Table 1. Mean Rates and Spreads over One-day LIBOR, 1/2/01-4/30/07

		Entire sample		"Regular" days		Quarter-ends		Year-ends	
Currency	Maturity	Rate,%	Spread, bp	Rate,%	Spread, bp	Rate,%	Spread, bp	Rate,%	Spread, bp
USD	1-day	2.90		2.92		2.94		2.63	
(U.S.	1-week	2.91	1.2	2.91	0.7	2.95	7.1	2.85	16.1
Dollar)	2-week	2.92	1.9	2.92	1.4	2.95	3.6	2.77	11.9
	1-month	2.93	3.3	2.95	2.6	2.96	2.9	2.74	11.6
GBP	1-day	4.48		4.47		4.49		4.48	
(British	1-week	4.47	-0.6	4.47	-0.6	4.48	3.5	4.47	-25.5
Pound)	2-week	4.50	2.1	4.50	1.7	4.52	7.6	4.44	-9.5
	1-month	4.52	4.2	4.52	4.7	4.55	5.5	4.43	-5.1
Euro	1-day	2.89		2.91		2.87		2.70	
	1-week	2.89	0.6	2.89	0.3	2.93	5.8	2.92	2.5
	2-week	2.90	0.9	2.90	0.4	2.91	3.8	2.83	5.8
	1-month	2.90	1.6	2.92	0.4	2.90	3.1	2.77	7.2
JPY	1-day	0.11		0.11		0.10		0.10	
(Japanese	1-week	0.11	0.3	0.11	0.2	0.13	2.1	0.12	1.0
Yen)	2-week	0.11	0.6	0.11	0.6	0.12	1.8	0.12	1.2
	1-month	0.12	1.3	0.12	1.0	0.12	1.9	0.12	2.2
CHF	1-day	1.19		1.21		1.21		0.96	
(Swiss	1-week	1.19	0.7	1.19	0.5	1.24	1.8	1.10	7.2
Franc)	2-week	1.20	1.2	1.20	0.9	1.24	1.7	1.06	9.5
	1-month	1.21	2.4	1.22	1.5	1.23	2.6	1.06	9.6
AUD	1-day	5.21		5.21		5.23		5.22	
(Australian	1-week	5.22	1.0	5.22	1.0	5.22	1.1	5.26	1.8
Dollar)	2-week	5.23	1.9	5.23	2.0	5.23	1.7	5.28	1.5
	1-month	5.25	3.3	5.24	3.7	5.25	2.3	5.25	3.2
CAD	1-day	3.19		3.20		3.23		2.97	
(Canadian	1-week	3.19	0.2	3.19	0.0	3.22	1.6	3.00	3.5
Dollar)	2-week	3.19	0.2	3.20	0.0	3.22	1.1	3.00	3.1
	1-month	3.20	0.5	3.20	0.2	3.23	0.5	3.00	3.3
	N	1599		1488; 1262; 1073		93; 188; 406		18; 49; 120	

Note: The sample period is January 2, 2001 through April 30, 2007. Spreads are over the one-day LIBOR in the same currency. A given day is included in the year-end (quarter-end) period for one-week, two-week, and one-month maturities if a loan originates on or before and matures after the third-to-last trading day of the year (quarter other than fourth). For example, the year-end period for one-month LIBOR includes second-to last trading day of November through third third-to-last trading day of December. For the purposes of constructing this table, the year-end and quarter-end periods for one-day LIBOR are the same as for the one-month LIBOR. The three values of N in the last row are for one-week, two-week, and one-month maturities, respectively. Due to Christmas and Boxing Day being non-trading days, the year-end period for one-week LIBOR covers only three trading days.

Table 2. Year-end and Quarter-end Effects in LIBOR Spreads.

Long rate	1-week		2-week		1-month	
Currency	YPH	QPH	YPH	QPH	YPH	QPH
USD	0.143***	0.056**	0.098***	0.030	0.089***	0.016
GBP	-0.251*	0.036	-0.114	0.064*	-0.101**	0.005
EUR	0.053	0.051***	0.070*	0.028**	0.074***	0.024
JPY	0.021*	0.019*	0.014*	0.013*	0.014*	0.008***
CHF	0.080**	0.011*	0.095**	0.006	0.082***	0.013
AUD	0.002	0.002	-0.009	-0.003	-0.006	-0.013
CAD	0.033***	0.013***	0.032***	0.013**	0.032***	0.006

The table reports estimated coefficients of the preferred habitat for liquidity indicator variables, YPH and QPH, from Equation (3):

$$r_t^n - r_t^m = \alpha_0 + \alpha_1 YPH + \alpha_2 QPH + c_1 MEnd + c_2 YTurn + c_3 Sept11 + c_4 afterSept11 + \varepsilon_t$$

YPH (QPH) equals 1 if an observation date is on or before and a maturity date of the loan is after the third-to-last trading day of the year (quarter other than fourth).

***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Table 3. Tests of the expectations hypothesis with and without the PH for liquidity controls

	α_0	α_1 (YPH)	α_2 (QPH)	β_1	β_2 (YPH)	β_3 (QPH)	ARCH-in-mean	Adj. R^2	AIC
				USD					
1w basic	0.011***			0.230**				0.094	-2.531
1w PH	0.008***	0.020	-0.034***	0.381***	0.127	0.006		0.568	-3.266
1w ARCH	-0.010	-0.005	-0.001	0.359***	0.422***	-0.080	-0.002**		-5.035
2w basic	0.021**			0.042				0.005	-2.688
2w PH	0.018***	0.006	-0.023**	0.157***	0.436***	-0.042		0.435	-3.250
2w ARCH	0.006	0.000	-0.010***	0.139***	0.547***	0.069***	-0.001***		-5.304
1m basic	0.039***			0.001				-0.001	-2.595
1m PH	0.037***	0.057***	-0.026***	0.008	-0.018	0.150**		0.288	-2.930
1m ARCH	0.034***	0.029***	-0.007***	0.059***	0.070***	0.083***	0.001		-4.982
				GBP					
1w basic	-0.005			0.136***				0.033	-0.417
1w PH	-0.001	-0.031	0.001	0.116***	0.883***	-0.122		0.087	-0.469
1w ARCH	-0.019	-0.032	0.004	-0.110***	0.391**	-0.179**	-0.009***		-1.141
2w basic	0.020*			0.063**				0.011	-0.426
2w PH	0.027**	-0.203**	0.010	0.038	0.444***	0.027		0.077	-0.491
2w ARCH	0.019**	-0.059***	-0.006	-0.008	0.303***	0.026	-0.004**		-1.102
1m basic	0.043***			0.027				0.003	-0.835
1m PH	0.048***	-0.153***	0.030	0.011	0.057	0.015		0.098	-0.930
1m ARCH	0.070***	-0.046***	0.026***	0.010	0.032*	0.039***	0.008**		-1.814
				Euro					
1w basic	0.005			0.382***				0.292	-2.527
1w PH	0.002	0.047***	0.004	0.393***	-0.022	-0.093*		0.358	-2.621
1w ARCH	-0.031***	0.061***	-0.001	0.298***	0.062	-0.006	-0.005***		-4.447
2w basic	0.010**			0.202***				0.100	-2.333
2w PH	0.006	0.010	-0.001	0.213***	-0.038	0.012		0.218	-2.468
2w ARCH	0.004	0.034***	0.004***	0.131***	-0.040**	-0.023	-0.001		-4.598
1m basic	0.021***			0.104***				0.036	-2.304
1m PH	0.014**	0.024**	-0.006	0.136***	-0.067*	-0.044		0.263	-2.568
1m ARCH	0.007	0.025***	-0.014**	0.056***	-0.009	0.075***	-0.002***		-4.473
				JPY					
1w basic	0.003*			0.312				0.071	-4.702
1w PH	0.003***	0.005	0.000	-0.482***	1.376***	1.290***		0.371	-5.086
1w ARCH	0.066***	0.033***	0.013***	-0.380	0.947	1.225	0.008***		-6.066
2w basic	0.006***			0.042				0.001	-4.598
2w PH	0.006***	-0.003	-0.002	-0.475***	1.235***	1.317***		0.498	-5.280
2w ARCH	0.066	0.002	-0.001	-0.489	1.195	1.321	0.007		-6.245
1m basic	0.013***			0.015				0.000	-4.335
1m PH	0.011***	-0.006**	-0.006*	-0.169**	0.719***	0.981***		0.256	-4.626
1m ARCH	0.043***	0.002	-0.005**	-0.207***	0.700***	0.831***	0.004***		-5.571

Table 3 (continued)

	α_0	α_1 (YPH)	α_2 (QPH)	β_1	β_2 (YPH)	β_3 (QPH)	ARCH-in-mean	Adj. R^2	AIC
				CHF					
1w basic	0.006***			0.381***				0.087	-3.264
1w PH	0.004**	0.051***	0.009	0.287***	0.122	0.543**		0.174	-3.359
1w ARCH	0.019**	0.055***	0.004	0.279***	0.371***	0.052	0.002*		-4.076
2w basic	0.013***			0.246**				0.040	-2.669
2w PH	0.010***	0.007	0.003	0.121	0.419***	0.278		0.247	-2.907
2w ARCH	0.000	0.011*	-0.004***	0.036	0.532***	0.049	-0.002***		-4.013
1m basic	0.031***			0.092				0.005	-1.924
1m PH	0.015**	0.054*	0.018	0.373***	-0.154	-0.556***		0.303	-2.276
1m ARCH	0.033***	0.018***	-0.001	0.230***	-0.135*	-0.284***	0.003***		-3.660
				AUD					
1w basic	0.009***			0.135*				0.009	-3.875
1w PH	0.008***	0.042***	-0.010**	0.011	0.543***	0.084		0.071	-3.935
1w ARCH	0.034***	0.032***	-0.006	0.217***	0.546***	0.156	0.004		-4.352
2w basic	0.018***			0.051				0.002	-3.368
2w PH	0.016***	0.041***	0.000	0.072	0.466	-0.098		0.053	-3.415
2w ARCH	0.007*	0.025***	-0.006**	0.129***	-0.257***	0.089	-0.001**		-4.334
1m basic	0.030***			0.043				0.002	-2.919
1m PH	0.025***	0.013	0.006	0.090	-0.2898	-0.048		0.063	-2.977
1m ARCH	0.051***	0.022***	0.009***	0.059***	-0.141***	-0.043	0.005***		-3.698
				CAD					
1w basic	0.003**			0.238***				0.120	-3.915
1w PH	0.003**	0.008	-0.014***	0.264***	0.375***	0.716***		0.269	-4.095
1w ARCH	-0.004	0.004	-0.010***	0.211***	0.326***	0.508***	-0.001***		-5.363
2w basic	0.007***			0.033				0.003	-3.588
2w PH	0.005**	0.020*	0.001	0.061	0.344	0.123		0.162	-3.757
2w ARCH	0.010***	0.001	-0.005***	0.166***	0.710***	0.392***	0.001**		-5.027
1m basic	0.015***			-0.069				0.014	-3.028
1m PH	0.008*	0.034***	0.009	-0.051	0.132	0.027		0.187	-3.216
1m ARCH	0.008***	0.028***	-0.003***	-0.049***	0.095***	0.118***	-0.001***		-4.475

The table reports key estimated coefficients from Equations (4), (5), and (6) – the basic OLS, the OLS with PH and other controls, and the ARCH-M model, respectively:

$$r_t^n - \frac{1}{k}\sum_t^{t+k-1} r_t^m = a_0 + \beta_1 (r_t^n - r_t^m) + \varepsilon_t \qquad (4),$$

$$r_t^n - \frac{1}{k}\sum_t^{t+k-1} r_t^m = a_0 + \alpha_1 YPH + \alpha_2 QPH + \beta_1 (r_t^n - r_t^m) + \beta_2 (r_t^n - r_t^m) YPH + \beta_3 (r_t^n - r_t^m) QPH$$
$$+ c_1 MEnd + c_2 YTurn + c_3 Sept11 + c_4 afterSept11 + \varepsilon_t \qquad (5),$$

$$r_t^n - \frac{1}{k}\sum_{t}^{t+k-1} r_t^m = a_0 + \alpha_1 YPH + \alpha_2 QPH + \beta_1 (r_t^n - r_t^m) + \beta_2 (r_t^n - r_t^m) YPH + \beta_3 (r_t^n - r_t^m) QPH$$
$$+ c_1 MEnd + c_2 YTurn + c_3 Sept11 + c_4 afterSept11 + \delta \log(h_t) + \varepsilon_t \qquad (6).$$

***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.