FORECASTING INTEREST RATES WITH EURODOLLAR FUTURES RATES

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INTRODUCTION

One economic role of interest rate futures markets is to provide forecasts of later interest rates. This article examines whether Eurodollar futures rates possess two key properties of rational forecasts or rational expectations. Do they fully reflect available information? Are they unbiased forecasts or do risk premia exist; and, if so, how large are the premia? By answering these questions, it can be shown how rational interest rate forecasts can be obtained from Eurodollar futures rates.

Cole, Impson, and Reichenstein (CIR) (1991) examined whether Treasury bill futures rates and no-change forecasts possess rational expectation properties. A no-change forecast predicts that later interest rates will equal today's rate. They concluded that futures rates on contracts expiring within two quarters fully reflect available information and are probably unbiased, while more distant contracts fail one or more tests of rationality. In addition, no-change forecasts consistently failed tests of rationality.

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This study examines the rationality of the Eurodollar futures market. Several factors motivate this study. First, the Eurodollar futures market dominates other futures markets on short-term interest rates. Open interest on IMM Eurodollar futures contracts currently exceeds 40 times the interest on 3-month Treasury bill futures contracts. Second, the contract tracks a private-sector interest rate, perhaps the most closely watched interest rate in the world. Third, the contract settles to yield while the Treasury bill futures contract settles to price. Since the yield–price relationship is nonlinear, conclusions based on a study of *prices* on Treasury bill futures do not necessarily apply to *yields* on Eurodollar futures [see Sundaresan (1991)]. Fourth, the Eurodollar contract must be cash settled, which removes concerns about the value of delivery options to the short position and the possibility of supply squeezes occurring near expiration. Fifth, improved methods are used to look at the key property of unbiasedness, which provide better estimates of the size of the risk premia.

This study's examination of the unbiasedness property improves upon earlier work in four ways. It uses an improved regression methodology. CIR (1991) regressed levels of interest rates on levels of interest rates. However, recent work implies that this methodology produces incorrect statistical inferences. Second, it examines profit opportunities on Eurodollar contracts extending out seven quarters, which exceeds the four contracts available on Treasury bill futures. If futures rates contain risk premia, they probably increase with the expiration date. Thus, the more distant contracts in the Eurodollar market provide better opportunities to judge the key property of unbiasedness. Third, it presents average profits per contract to various long futures strategies. Presenting the evidence in dollar terms instead of the arcane language of regressions makes the results more useful to market participants. For example, the average profit indicates the expected cost to a short hedger of insuring against a drop in the value of a long spot position. Fourth, it notes a recent theoretical advance that says that risk premia should be embedded in futures interest rates [Meulbroek (1992)].

This article tests whether Eurodollar futures rates possess two rational-expectations properties. Do they fully reflect public information and do they contain risk premia? The results differ markedly between two periods: 1982.2 (June 1982)–1986.2 and 1986.3–1991.2. During the early period, interest rates fell sharply and consistently. It is argued that this unique period is not representative of today's futures market. In the early period, futures rates lack both properties of rational expectations. For the late period, futures rates fully reflect a broad range of information. Although data limitations prevent a definitive conclusion, the results best support the argument that (a) the one-quarter futures rate provides an unbiased forecast of LIBOR at expiration and (b) more distant futures rates contain risk premia that increase with the contract expiration date.

THE EURODOLLAR FUTURES CONTRACT

Introduced in December, 1981 by the Chicago Mercantile Exchange (CME), the Eurodollar futures contract is based on a 3-month, $1 million Eurodollar time deposit. Unlike other interest rate futures contracts, it must be cash settled. Cash settlement is based on the average 3-month London Interbank Offer Rate (LIBOR) at select London banks.

This study examines whether Eurodollar futures rates deviate from expected LIBOR at expiration. It is concluded that, with the possible exception of risk premia, futures rates should not deviate from expected LIBOR at expiration. Because it is cash settled, the futures contract contains no delivery options and default risk appears negligible. Two risk premia may be present. A liquidity or maturity risk premium and a risk premium associated with the cash settlement of futures contracts. The theory behind the cash-settlement risk premium is presented later.

DEFINITIONS OF VARIABLES

The entire history of the Eurodollar futures market through 1991.2 is considered. Data come from *The Wall Street Journal.* Quarterly observations are used due to the popularity of one-quarter-ahead interest rate forecasts [See CIR (1991) and Pesando and Plourde (1988)]. FN_t denotes the Eurodollar futures rate at time t on the contract that expires in N quarters. Table I summarizes futures activity on December 18, 1989, the expiration date of the December, 1989 contract. $F3_t$ is the September, 1990 contract rate of 7.70%. It provides forecasts of the September contract rate in March ($F2_{t+1}$), the September contract rate in June ($F1_{t+2}$), and LIBOR in September (L_{t+3}). Similarly, $F7_t$ (September, 1991 contract rate) through $F1_t$ (March 1990) provide one-quarter or one-step forecasts of, respectively, $F6_{t+1}$ through L_{t+1}.

TABLE I
Schedule of Eurodollar Futures Market Contracts on the International Monetary Market As of Market Close December 18, 1989 (Points of 100%)

						Yield		*Open*
	Open	*High*	*Low*	*Settle*	*Chg*	*Settle*	*Chg*	*Interest*
Dec	91.39	91.40	91.38	91.37	−0.10	8.63	+0.10	127,139
Mr90	92.12	92.19	92.12	92.18	+0.02	7.82	−0.02	234,470
June	92.30	92.38	92.29	92.37	+0.04	7.63	−0.04	95,281
Sept	92.25	92.30	92.24	92.30	+0.03	7.70	−0.03	54,836
Dec	92.02	92.07	92.00	92.06	+0.03	7.94	−0.03	39,017
Mr91	91.86	91.95	91.86	91.94	+0.05	8.06	−0.05	34,432
June	91.71	91.79	91.71	91.79	+0.06	8.21	−0.06	32,284
Sept	91.65	91.71	91.63	91.71	+0.06	8.29	−0.06	25,013
Dec	91.55	91.62	91.55	91.61	+0.06	8.39	−0.06	18,536
Mr92	91.62	91.66	91.62	91.67	+0.05	8.33	−0.05	16,392
June	91.59	91.61	91.59	91.63	+0.04	8.37	−0.04	10,394
Sept	91.53	91.56	91.53	91.56	+0.03	8.44	−0.03	6,553
Dec	91.45	91.47	91.45	91.48	+0.03	8.52	−0.03	2,683
Mr93	91.48	91.50	91.48	91.51	+0.03	8.49	−0.03	4,700
June	91.46	91.46	91.46	91.47	+0.03	8.53	−0.03	2,227
Sept	91.42	91.42	91.42	91.43	+0.03	8.57	−0.03	1,974

Source: *The Wall Street Journal.*

Forecast errors are defined as predicted minus actual rates. Two sets of errors are examined. One-step forecast errors are defined:

$$\text{Long10}_t = F1_t - L_{t+1};$$

$$\text{Long21}_t = F2_t - F1_{t+1};$$

$$\text{Long32}_t = F3_t - F2_{t+1};$$

$$\text{Long43}_t = F4_t - F3_{t+1};$$

$$\text{Long54}_t = F5_t - F4_{t+1};$$

$$\text{Long65}_t = F6_t - F5_{t+1}; \qquad \text{and}$$

$$\text{Long76}_t = F7_t - F6_{t+1}.$$

The "Long" designation is adopted because each error reflects the gain or loss to a long position in the futures contract. Errors on contracts held to expiration take the form: $EN_t = FN_t - L_{t+N}$. Average profits on long positions provide estimates of risk premia or changes in those risk premia. They also provide estimates of the cost to a short hedger of insuring a long spot position. All forecast errors take the date of the initial futures date.

Most analyses in this study rely on one-step forecasts—Long10_t through Long76_t. Data limitations preclude an effective direct analysis of questions related to multi-step forecasts. Based on a careful examination of one-step forecasts, one can make reasonable inferences about, for example, the size of the risk premium imbedded in $F4_t$.

FUTURES RATES AS RATIONAL EXPECTATIONS

Rational expectations or rational forecasts in Muth's (1961) sense must possess two key properties. They must fully reflect public information and they must be unbiased. $F1_t$ through $F7_t$ are tested to see if they provide rational expectations of, respectively, L_{t+1} through $F6_{t+1}$. Each property is tested in order.

Tests of Orthogonality of Errors

Tests of the first property are called orthogonality-of-errors tests. If futures rates fully reflect public information, their prediction errors should show no significant relation to prior economic variables. A significant relationship between forecast errors and public information implies that the forecasts are not rational since they could have been significantly improved with the information.

The tests regress one-step forecast errors on the most recent observation of a macroeconomic variable, X_t:

$$\text{Long}_t = \alpha + \beta X_t + e_t$$

The joint hypothesis is: $H\colon\ (\alpha, \beta) = (0, 0)$.

In these tests a wide range of 14 economic variables are examined. The variables include three general macroeconomic variables—unemployment rate (UN), growth in industrial production as measured by the Industrial Production Index (IP), and National Income Accounts budget deficit (GOV); a microeconomic variable—price of West Texas crude oil (OIL); four money supply and related variables—inflation rate as measured by the Consumer Price Index (INF), change in the inflation rate (CHG INF), growth rate in the $M1$ money supply (MG), and growth rate in the adjusted monetary base (BG); three exchange rates—mark (DM), yen (¥), and pound sterling (£); and three interest rate variables—spread between 10-year and 1-year Treasury rates (SP10), 1-year LIBOR (1YRL), and change in 3-month LIBOR (CHG LIB). Data come from the Federal Reserve Bank of Dallas and *The Wall Street Journal*.

It is important to use observations on variables that were publicly available at the time of the forecasts. To this end, observations from the second month in a quarter are used for the following: unemployment rate, Industrial Production Index, Consumer Price Index, $M1$, monetary base, and price of West Texas crude oil. The federal deficit from the prior quarter is considered the most recent observation. Panels A and B of Table II summarize the regression results for, respectively, the early and late periods.

In the 1982.2–1986.2 early period, the forecast errors for each of the one-step forecasts are significantly associated with public information. Consider first the results for Long10 through Long43 on which there exist 17 observations. Each set of forecast errors shows significant correlations at the 5% level at least twice and at the 10% level at least 10 times. There are only eight observations on Long54 through Long76. Despite the few observations, each set of forecasts shows significant correlations at the 10% level at least three times. These tests show that during the 1982.2–1986.2 period Eurodollar futures rates do not fully reflect public information nor do they provide good one-step forecasts of interest rates.

Since 1986.3 (Panel B), futures-market forecast errors have not been significantly associated with public information. None of the correlations show significance at even the 10% level. The results imply that today's one-quarter through seven-quarter futures rates fully reflect the information contained in macro series, micro series, exchange rates, and interest rates.[1]

TESTS OF UNBIASEDNESS

In model form, the expected profit on a N-quarter futures contract held until expiration, $E(EN_t)$, can be expressed:

$$E(EN_t) = FN_t - E(L_{t+N}) = RPN_t$$

[1]Separate tests imply that futures rates since 1986.3 also reflect the information contained in prior changes in futures rates. The design of the tests follow the "tests of consistency" in CIR (1991) and are available upon request.

TABLE II

Orthogonality of Errors Tests

$$\text{Long}_t = \alpha + \beta X_t + e_t$$

$$H:\ (\alpha, \beta) = (0, 0)$$

IND. VAR.	*Long10*	*Long21*	*Long32*	*Long43*	*Long54*	*Long65*	*Long76*
	SIGNIFICANCE LEVELS						
A. 1982.2–1986.2							
UN	0.063[b]	0.077[b]	0.080[b]	0.077[b]	0.114	0.142	0.137
IP	0.014[a]	0.013[a]	0.010[a]	0.006[a]	0.100[b]	0.179	0.184
GOV	0.006[a]	0.020[a]	0.042[a]	0.046[a]	0.251	0.160	0.163
OIL	0.056[b]	0.085[b]	0.103	0.103	0.282	0.179	0.185
INF	0.044[a]	0.050[a]	0.075[b]	0.088[b]	0.133	0.118	0.121
CHG INF	0.056[b]	0.075[b]	0.100[b]	0.102	0.100[b]	0.092[b]	0.096[b]
MG	0.059[b]	0.085[b]	0.079[b]	0.067[b]	0.060[b]	0.037[a]	0.037[a]
BG	0.063[b]	0.088[b]	0.097[b]	0.095[b]	0.146	0.027[a]	0.025[a]
DM	0.052[b]	0.071[b]	0.082[b]	0.087[b]	0.209	0.138	0.138
¥	0.024[a]	0.044[a]	0.065[b]	0.071[b]	0.315	0.155	0.156
£	0.065[b]	0.088[b]	0.100[b]	0.100[b]	0.103	0.123	0.124
SP10	0.025[a]	0.059[b]	0.078[b]	0.076[b]	0.286	0.176	0.186
1YRL	0.072[b]	0.148	0.209	0.239	0.300	0.102	0.108
CHG LIB	0.065[b]	0.089[b]	0.103	0.102	0.123	0.005[a]	0.007[a]
B. 1986.3–1991.1							
UN	0.896	0.759	0.612	0.603	0.651	0.782	0.787
IP	0.386	0.790	0.856	0.822	0.835	0.888	0.851
GOV	0.979	0.943	0.869	0.814	0.816	0.878	0.857
OIL	0.116	0.232	0.362	0.460	0.554	0.711	0.797
INF	0.665	0.767	0.780	0.770	0.792	0.872	0.860
CHG INF	0.794	0.825	0.832	0.823	0.839	0.866	0.819
MG	0.519	0.582	0.624	0.701	0.791	0.887	0.857
BG	0.670	0.666	0.613	0.646	0.723	0.796	0.805
DM	0.372	0.792	0.847	0.828	0.838	0.886	0.847
¥	0.797	0.947	0.888	0.830	0.838	0.887	0.861
£	0.422	0.730	0.770	0.756	0.799	0.866	0.853
SP10	0.832	0.966	0.890	0.826	0.819	0.882	0.856
1YRL	0.459	0.340	0.268	0.264	0.307	0.402	0.423
CHG LIB	0.977	0.810	0.791	0.709	0.720	0.819	0.826

[a,b]Denote significance at 5 and 10% levels, respectively.

Values denote significance levels at which the joint null hypothesis of orthogonality of errors is rejected.

$\text{Long}_t = F1_t - L_{t+1}$, where $F1_t$ denotes the one-quarter Eurodollar futures rate at time t and L_{t+1} denotes 3-month LIBOR at time $t + 1$. $\text{Long43}_t = F4_t - F3_{t+1}$. Other Long definitions are parallel.

For 1982.2–1986.2, there exist 17 observations each on Long10 through Long43 and 8 observations each on Long54 through Long76.

where RPN_t is the risk premium, if any, embedded in a N-quarter futures contract. Accordingly, $\text{Long}43_t$ and other one-step long futures strategies offer a positive expected return:

$$E(\text{Long}43_t) = E(E4_t) - E(E3_t) = RP4_t - RP3_t > 0$$

Under the theory of normal backwardation, Keynes (1930) and Hicks (1939) argue that investors hold short-term debt in their spot portfolios. To hedge the interest rate risk, they take short futures positions. To induce a sufficient number of long speculators, the futures price must be bid down and the futures interest rate must be bid up above expected LIBOR at expiration. They also argue that the risk premium to long speculators increases with the expiration date on the futures contract.

Meulbroek (1992) presents another reason why futures rates may contain risk premia. She argues that the daily settlement of futures contracts should force futures *prices* below corresponding forward *prices*. By marking-to-market, the long position realizes a cash inflow when interest rates fall and are low. The long realizes a cash outflow when interest rates rise and are high. The cost in terms of foregone interest when interest rates rise exceeds the gain when interest rates fall. This nonsymmetrical payoff forces futures prices below forward prices; that is, it forces futures rates above forward rates. Furthermore, she argues that this differential should increase with the expiration date. Accordingly, even if forward rates are unbiased forecasts of later spot rates, futures rates could contain risk premia.

On the other hand, Telser (1958), Gray (1961), and others argue that no risk premia exist in futures prices. The futures price (interest rate) equals the expected spot price (rate) at expiration. According to the no-risk-premium school, neither a one-quarter long futures strategy nor a buy-and-hold-till-expiration strategy should produce profits that deviate significantly from zero.

The question of whether risk premia exist must be answered empirically. Furthermore, even if risk premia exist during one time period it does not guarantee that they will continue to exist in others. New financial instruments and regulatory requirements (among other things) could change market dynamics. In the absence of such changes, however, it is reasonable to anticipate the continuation of the status quo.

Two types of tests of risk premia are used. The first is a test of unbiasedness. Support for the unbiasedness hypothesis supports the no-risk-premium school. The second type of test examines (a) average profits on one-quarter long futures positions (e.g., Long10, Long21, etc.) and (b) average profits on long futures positions that are bought and held until expiration (e.g., *E*1, *E*2, etc.). Average profits near zero support the no-risk-premium school.

Table III summarizes tests of the unbiasedness of one-step Eurodollar futures rate predictions. Unbiasedness tests often regress actual rates on forecast rates. Elam and Dixon (1988), Dwyer, Williams, Battalio, and Mason (1989) and others argue that regressing levels of rates on levels of rates provides incorrect statistical inferences. Using simulations, Elam and Dixon show that the method often incorrectly concludes that futures rate forecasts are biased.

To avoid this criticism, actual *changes* in rates are regressed on predicted *changes*:[2]

$$\text{Actual Chg}_t = \alpha + \beta(\text{Pred. Chg})_t + e_t$$

The null hypothesis remains H: $(\alpha, \beta) = (0, 1)$. In the regression, α is the negative of the risk premium or change in risk premium. Panels A and B of Table III summarize the results for the early 1982.2–1986.2 and the late 1986.3–1991.1 periods.

The early period rejects at better than the 10% level the unbiasedness of *F*1 through *F*4 as one-step predictions. The unbiasedness of *F*1 is rejected at the 2.6% level, *F*2 at the 7.2% level, *F*3 at the 6.5% level, and *F*4 at the 5% level. Although the few observations on *F*5 through *F*7 prevent rejection of the null hypothesis at conventional levels, point estimates of both α and β suggest that a bias exists.

For the late period, regression 8 is reviewed and then the other regressions as a group are reviewed. Regression 8 implies that the one-quarter futures rate (*F*1) provides an impressive forecast of LIBOR. The R^2 of 0.235 coupled with a β estimate close to 1.0 indicates that *F*1 predicted about 24% of the movement in LIBOR. In regressions 9 through 14, all but one slope coefficient is within one standard error of 1.0. The typical intercept, α, is about −0.14 with a standard error of about 0.25. Using two standard errors as the confidence interval, one can confidently place the typical α in the range −0.64–0.36; that is, one can confidently place the risk premium or change in risk premium in the range −0.36–0.64. This range includes zero and thus supports the no-risk-premium school. However, it *best* supports the existence of a modest risk premium. Unfortunately, the regression tests cannot

[2]Dickey–Fuller tests support this decision to regress changes in interest rates on changes in rates.

TABLE III
Unbiasedness Tests
Actual $\text{Chg}_t = \alpha + \beta(\text{Pred. Chg})_t + e_t$
$H\colon (\alpha, \beta) = (0, 1)$

Reg. No.	Actual Change in	Pred. Change from	α	β	R^2	Sig. Level	n
A. 1982.2–1986.2							
1	LIBOR	$F1$	−0.56	0.05	0.001	0.026[a]	17
			(0.36)	(0.67)			
2	$F1$	$F2$	−0.43	−0.36	0.002	0.072[b]	17
			(0.78)	(2.07)			
3	$F2$	$F3$	−1.45	3.37	0.116	0.065[b]	17
			(0.73)	(2.40)			
4	$F3$	$F4$	−1.74	4.83	0.138	0.050[a]	17
			(0.85)	(3.12)			
5	$F4$	$F5$	−1.48	4.25	0.032	0.297	12
			(1.97)	(7.35)			
6	$F5$	$F6$	−2.55	7.27	0.160	0.120	8
			(1.78)	(6.80)			
7	$F6$	$F7$	−2.13	6.12	0.131	0.137	8
			(1.58)	(6.43)			
B. 1986.3–1991.1							
8	LIBOR	$F1$	−0.01	0.88	0.235	0.954	19
			(0.05)	(0.39)			
9	$F1$	$F2$	−0.02	0.60	0.021	0.894	19
			(0.20)	(0.99)			
10	$F2$	$F3$	−0.14	1.29	0.053	0.876	19
			(0.27)	(1.33)			
11	$F3$	$F4$	−0.42	2.92	0.264	0.248	19
			(0.26)	(1.18)			
12	$F4$	$F5$	−0.11	1.01	0.033	0.839	19
			(0.27)	(1.33)			
13	$F5$	$F6$	−0.19	1.88	0.113	0.704	19
			(0.23)	(1.28)			
14	$F6$	$G7$	−0.10	1.09	0.034	0.859	19
			(0.24)	(1.42)			

[a,b]Denote significance at the 5 and 10% levels, respectively.
Sig. Level denotes the significance level at which the joint null hypothesis of unbiasedness can be rejected. The number of observations is n.
R^2 indicates the percent of variation in actual changes that can be explained by the independent variable.
Parentheses enclose standard errors.

definitively distinguish between the following hypotheses: (a) no risk premia exist; and (b) modest risk premia exist.

Table IV summarizes the second set of tests for the existence of risk premia. For both the early and late periods, it shows average profits on one-step long positions—i.e., Long10 through Long76—and average

TABLE IV
Average Gains to Long Futures Positions

	1982.2–1986.2 Average Gain in bp	Sig. Level	π/n	Max Loss in bp	1986.3–1991.1 Average Gain in bp	Sig. Level	π/n	Max Loss in bp
Long10	83.5	0.018	13/17	51	0.9	0.954	8/19	87
Long21	88.5	0.025	11/17	142	4.7	0.801	11/19	137
Long32	81.4	0.030	10/17	126	9.4	0.637	11/19	128
Long43	78.2	0.030	10/17	100	11.4	0.549	11/19	130
Long54	91.8	0.056	5/8	48	10.6	0.547	12/19	140
Long65	96.0	0.053	6/8	57	8.0	0.622	12/19	136
Long76	100.0	0.052	6/8	66	8.4	0.579	12/19	131
E1	83.5	0.018	13/17	51	0.9	0.954	8/19	87
E2	155.1	NA	13/17	55	4.5	NA	9/18	168
E3	202.3	NA	14/17	76	13.5	NA	10/17	184
E4	240.9	NA	14/17	85	22.3	NA	9/16	235
E5	326.6	NA	12/12	0	31.7	NA	8/15	127
E6	323.8	NA	8/8	0	39.3	NA	8/14	129
E7	356.2	NA	8/8	0	44.2	NA	9/13	233

Long43$_t$ = $F4_t - F3_{t+1}$, where FN_t denotes the N-quarter Eurodollar futures rate at time t. Other Long definitions are parallel. $EN_t = FN_t - L_{t+N}$, where the later denotes 3-month LIBOR at $t + N$. $E1_t$ = Long10$_t$.
Sig. level denotes the significance at which we reject the null hypothesis, H: average gain = 0. Significance levels for $E2$ ($F2_t - L_{t+2}$) and beyond are not meaningful due to overlapping time periods. π denotes the number of profitable contracts and n the number of contracts in the period. Max loss shows the maximum loss per contract to futures position in basis points.

profits on contracts held to expiration—$E1$ through $E7$. Average profits in the early period dramatically exceed average profits in the late period. Daigler and Nurawan (1990) contend that there was a change in the pricing of Eurodollar futures contracts after the June, 1986 (1986.2) contract. The average profits in this table, as well as the earlier regression results, support their contention.

In the 1982.2–1986.2 period, investors with long futures positions consistently earn large profits. For example, an investor who buys a four-quarter futures contract and sells it as a three-quarter futures contract (i.e., Long43) realizes an average profit of 78.2 basis points or $1,955 per contract. Other long strategies earn even more. Average profits deviate significantly from zero at the 6% level.

For the early period, strategies of buying futures contracts and holding to expiration prove to be *consistently* profitable as well. Buy-and-hold strategies produce average profits that increase from 83.5 basis points for $E1$ to 356.2 basis points for $E7$. In total, 85.4% of the buy-and-hold positions produce a profit. And the *average* profit for each buy-and-hold strategy exceeds the *maximum* loss. Clearly, early-period profits on long positions exceed amounts that could be considered normal compensation for bearing risk.

The experience since 1986.3 differs markedly. The one-step strategies—Long10 through Long76—produce average profits of 0.9, 4.7, 9.4, 11.4, 10.6, 8.0, and 8.4 basis points, respectively. These modest average profits reflect reasonable a priori estimates of maturity risk premia. The long position earns a profit 57.9% of the time, only slightly more often than half the time. Further, the maximum loss to the long far exceeds the average gain. Although the no-risk-premia hypothesis cannot be rejected, the results best support the existence of modest risk premia in all but the nearby futures rate.

Return to the IMM Eurodollar report in Table I. This study holds that today's one-quarter futures rate ($F1$) fully reflects public information and provides an unbiased forecast of LIBOR one quarter hence. Table IV suggests that $F1$ contains a one basis point risk premium. And Meulbroek (1992) suggests that daily settlement alone may produce a two basis point risk premium. Although this study views $F1$ as an unbiased forecast, it does not argue with others who prefer to forecast LIBOR by subtracting a couple of basis points from $F1$. $F2$ through $F7$ also fully reflect public information. However, the best forecasts of LIBOR occur when estimates of risk premia in Table IV are subtracted from $F2$ through $F7$. Applying this method to futures rates on December 18, 1989 in Table I produces forecasts of LIBOR in March, 1990 of 7.82%; June, 1990 of 7.59% (7.63 − 0.04); September, 1990 of 7.57% (7.70 − 0.13); December, 1990 of 7.72%; March, 1991 of 7.74%; June, 1991 of 7.82%; and September, 1991 of 7.85%.

EARLY PERIOD VERSUS LATE PERIOD RESULTS

Early period results imply that financial markets did not rationally price Eurodollar futures contracts through about June, 1982. Three possible explanations for these results are presented.

First and foremost, interest rates between 1982.2 and 1986.2 experienced the sharpest and most persistent declines of this century. Three-month LIBOR was perched at 15.25% in June, 1982 before plummeting almost 6% in the next 9 months. It reached an early-sample-period low of 7% in June, 1986. Not surprising, long futures strategies proved profitable for this period. After 17 years of persistent upward trends in levels of inflation and interest rates, financial markets were reluctant to believe that the sharp drop in interest rates at the beginning of this period would remain, much less that the downward trend would continue.

Second, prior studies conclude that futures contracts are often mispriced in early years of trading [Erhardt and Tucker (1990); Figlewski (1984)]. This explanation may account for some of the unusual profits in the early period.

Finally, the volume on Treasury bill futures contracts fell sharply about mid-year 1986. The associated increase in trading volume on the Eurodollar contract may reflect a move toward greater efficiency in the Eurodollar contract.

In short, the evidence strongly supports a distinction between the early and late period with the breaking point near mid-1986. Daigler and Jurawan (1990) also find evidence of a structural change about mid-1986. They, too, are unsure why the change occurred. For purposes of analyzing the Eurodollar market today, the reasons for the separate periods are irrelevant.

CONCLUSIONS AND IMPLICATION

This article seeks to determine whether Eurodollar futures rates serve as rational expectations or rational predictions of later interest rates. Specifically, do they fully reflect public information and are they unbiased forecasts of later interest rates? The results differ markedly between two periods: 1982.2–1986.2 and 1986.3–1991.2. For the early period, the results imply that Eurodollar futures rates are not good forecasts of later interest rates, including later spot LIBOR. They do not fully reflect public information and they produce upward-biased forecasts of later interest rates.

The authors believe that the results for the 1986.3–1991.2 period reflect market prospects today. The results imply that futures rates fully reflect information contained in a broad range of economic data. They suggest that the futures rate on the contract expiring in one quarter provides an unbiased forecast of LIBOR at expiration, but more distant futures rates contain risk premia that increase with contract expiration date.

Individuals sometimes rely on average interest rate forecasts from a survey of economists. Forecasts from futures markets offer two advantages compared to survey predictions. First, they are timely. Survey results are often dated by the time they appear in print [Reichenstein (1991)]. Second, futures market participants have a stronger incentive than economists to carefully assess the significance of all public information. Every day they risk their financial wealth on their forecasts.

Instead of relying on an average interest rate forecast from a survey, this study suggests that individuals may base their short-term interest rate forecasts on Eurodollar futures rates. Forecasts of spot LIBOR can be obtained by subtracting estimates of risk premia in Table IV. This provides forecasts of *changes* in LIBOR, which should closely correspond to *changes* in other short-term interest rates on high-grade debt.

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