

Eurodollar and Fed Funds Futures

Bjørn Eraker

Wisconsin School of Business

January 8, 2015

Eurodollars are USD deposited outside the US (not necessarily just Europe).

The funds are not subject to Fed regulation.

Eurodollars can be invested with various investment horizons, at the USD denominated London-Interbank-Offer-Rate (LIBOR).

Is the rate at which banks are willing to borrow to other banks in the London interbank market. It represents the borrowing rate of large banks.

Libor is a widely used benchmark for other floating rate loans. For example, a corporation may be offered a loan at X bp over LIBOR.

Since counter-parties do not have the credit quality of the US government, LIBOR contains a positive spread to US T-Bills.



Figure: Historical 90 day LIBOR over T-Bill Spread. TED3 function in Bloomberg.

How Libor is determined

The USD LIBOR is determined by a survey to 16 banks.

Since its a survey, people can lie

WSJ in May 29, 2008 ran a story suggesting banks underreported their borrowing cost, suggesting that they wanted to convey a picture of lesser borrowing costs or default spread amid concerns of their financial health. This would lead to a downward bias in reported LIBOR rates.

Libor manipulation to lower rate

“ Hi Guys, We got a big position in 3m libor for the next 3 days. Can we please keep the lib or fixing at 5.39 for the next few days. It would really help. We do not want it to fix any higher than that. Tks a lot. ”

Barclays Bank trader in New York to submitter,
13 September 2006^[23]

Figure: Libor Rigging Scandal - quote from anon Barkleys trader.
Source: Wiki.

The 2008 WSJ story was initially contradicted, but investigations throughout 2010 and 2011 eventually uncovered large scale manipulations.

Among others Bank of America, Barclays, UBS, Royal Bank of Scotland, Deutsche Bank and JP Morgan were fined. UBS was fined \$1.5BN.

In the aftermath, litigation was brought from several trading counter-parties, including municipalities, cities, and homeowners who had their floating rates determined on the first day of the month (the rates would be manipulated up on that date). Read more about the scandal in Wiki and online news-sources.

The initial WSJ report has been covered in FIN365 and FIN740 since 2008.

<HELP> for explanation.

97) Change Country		98) Feedback		12:20:35		Treasury & Money Markets: United States						
1) FED Funds(FOMC)		09:12	US T-Bill			EURO\$DEP		Reverse (Bid)		Repo (Ask)		
BID/ASK	0.1300	0.1400	4W	0.01	-0.01	0.01	0.01	0/N	0.16	0.13		
LST/OPEN	0.1300	0.1300	3M	0.02	+0.00	0.02	0.02	1W	0.15	0.12		
HIGH/LOW	0.2300	0.1200	6M	0.08	-0.02	0.09	0.08	2W	0.15	0.12		
			1Y	0.21	-0.01	0.22	0.21	1M	0.16	0.13		
Dow Jones		S&P 500 Future			NASDAQ Composite Index		CRB Commodity Index					
DJIA	17560.77	-272.22	SPX Future 2022.50-23.8			CCMP	4676.11	-50.71	CRB	227.21	-1.21	
2) US Bonds (BBT)		Comm Paper		90D EUR\$ FUT		Funds Future		LIBOR Fix				
T 0 5/8 12/31/16	0.665	99-29 3/4	99-29+	+ 00	15D	0.150	MAR	99.7150	JAN	99.885	0/N	0.11260
T 1 1/2 12/15/17	1.049	99-27 1/2	99-27+	+ 00	30D	0.160	JUN	99.5550	FEB	99.880	1W	0.13480
T 1 5/8 12/31/19	1.578	100-07	100-07 3/4	+ 04+	60D	0.190	SEP	99.3450	MAR	99.880	1M	0.16750
T 2 3/8 12/31/21	1.868	101-21	101-21+	+ 09+	90D	0.220	DEC	99.0950	APR	99.875	2M	0.21420
T 2 1/2 11/15/24	2.060	101-21+	101-22	+ 14+	120D	0.260	MAR	98.8450	MAY	99.840	3M	0.25560
T 3 11/15/44	2.632	107-18	107-18+	+1-06	180D	0.320	JUN	98.6000	JUN	99.800	6M	0.36480
4) Spot FOREX (FXC)		Key Rates		Swaps		10Y Note Future		5) 30Y MBS (BBTM)				
JPY	119.766	Prime	3.25	3Y	1.2648	CBT	127-20+	+ 15+	GNMA 3. 105-16 105-17 + 06			
EUR	1.1919	BLR	2.00	5Y	1.7045	Commodities		GOLD 3.5 104-18 104-19 + 08				
GBP	1.5234	FDTR	0.25	10Y	2.1705	NYM WTI		50.36 -2.33				
CHF	1.0079	Discount	0.75	30Y	2.5775	GOLD		1197.33 +8.10				
CAD	1.1790							FNMA 3.5 104-26 104-27 + 07				
30) Economic Releases (ECO)												
Date	Time	A	M	R	Event	Period	Surv(M)	Actual	Prior	Revised		
31)	01/05 09:4				ISM New York	Dec	--	70.8	62.4	--		
32)	01/05				Wards Domestic Vehicle Sales	Dec	13.70M	--	13.78M	--		
33)	01/05				Wards Total Vehicle Sales	Dec	16.90M	--	17.08M	--		
34)	01/06 07:3				RBC Consumer Outlook Index	Jan	--	--	53.3	--		
35)	01/06 09:4				Market US Composite PMI	Dec F	--	--	53.8	--		
Australia 61 2 9777 8600 Brazil 5511 2395 9000 Europe 44 20 7330 7500 Germany 49 69 9204 1210 Hong Kong 852 2977 6000												
Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2015 Bloomberg Finance L.P.												
SN 842817 EST GMT-5:00 H443-1962-2 05-Jan-2015 12:20:35												

Figure: The BTMM screen in Bloomberg gives LIBOR rates, among other things.

Example

The rates are quoted on a 30/360 basis. Suppose we invest 100,000 for three months at 2.23625. We collect

$$100,000\left(1 + \frac{2.23625}{100} \times \frac{90}{360}\right) = 100,559$$

in principal + interest after 3M.

Eurodollar Futures

The CME trades futures contracts on interest rates directly (ie. these are NOT futures on bonds...)

We will see that these contracts allow us to buy and sell duration directly.

Transacting in this market allow us to readily hedge interest rate risks.

Contracts written on 90 LIBOR.

<HELP> for explanation.

Screen Printed

1MM EURODOLLAR FUTURES ANALYSIS

3/25/10 Valuation	7-day	1-mth	2-mth	3-mth	4-mth	5-mth	6-mth	9-mth	1year
LIBOR RATES	0.234	0.247	0.264	0.288	0.326	0.369	0.437	0.666	0.908
SWAP RATES	2Y 1.214	3Y 1.812	4Y 2.311	5Y 2.711	7Y 3.285	10Y 3.776			

FUTURES 1 <G0> for convexity bias analysis

Contract:	Jun10	Sep10	Dec10	Mar11	Jun11	Sep11	Dec11	Mar12	Jun12	Sep12
Price	99.610	99.410	99.105	98.755	98.380	98.015	97.675	97.375	97.095	96.835
Rate <small>conv-adj</small>	0.390	0.590	0.895	1.245	1.620	1.985	2.325	2.625	2.905	3.165
Fut Valuatn <small>Y/N</small>	6/16	9/15	12/15	3/16	6/15	9/21	12/21	3/21	6/20	9/19
Days	83	174	265	356	447	545	636	727	818	909

YIELD CURVES

				1.0YR	1.5YR	2.0YR	2.5YR			
Cash String	0.282	0.419	0.646	0.887	0.988	1.068	1.142	1.215	1.365	1.518
Fut String	0.282	0.338	0.425	0.546	0.698	0.868	1.032	1.199	1.362	1.521
Spread	+0.00	-0.08	-0.22	-0.34	-0.29	-0.20	-0.11	-0.02	+0.00	+0.00

FORWARD ANALYSIS

LIBOR Fwd	0.54	1.08	1.58
Futures	0.39	0.59	0.90
Spread	+0.15	+0.49	+0.69

Futures daytype: actual/360

Strip yield: < 1 yr: actual/360

Strip/Coupn: > 1 yr: bond equiv

Freq S Daytype ACT/ACT

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 9204 1210 Hong Kong 852 2977 6000
 Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2010 Bloomberg Finance L.P.
 SN 827136 H187-1131-0 25-Mar-2010 11:04:36

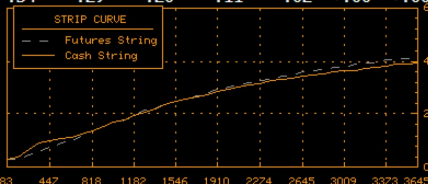


Figure: Bloomberg Libor screen.

Nov 14, 2008 CME prices (from cme.com):

MTH/ STRIKE	--- SESSION --- LAST	--- SETT	PT CHGE	EST VOL	---- PRIOR SETT	DAY VOL	---- INT
NOV08	97.73	97.74	-.0325	556	97.7725	42038	116400
DEC08	97.705A	97.705	-.10	5510	97.805	305669	566828
JAN09	----	97.81	-.115		97.925	285	9584
FEB09	----	97.84	-.11		97.95		766
MAR09	97.86A	97.855	-.095	5511	97.95	273343	278162
APR09	----	97.855	-.09		97.945		99
JUN09	97.835B	97.835	-.09	5910	97.925	258788	974666
SEP09	97.78A	97.775	-.075	1964	97.85	232756	893646
DEC09	97.63A	97.63	-.055	5548	97.685	233425	796881
MAR10	97.58A	97.58	-.025	3127	97.605	165396	605702
JUN10	97.38A	97.38	UNCH	2952	97.38	113575	400480
SEP10	97.09A	97.09	+.02	3222	97.07	91065	346916
DEC10	96.71A	96.70	+.04	3543	96.66	54989	243631

Example

First, the price is not actually a price, but rather a way to quote the a rate. The rate on the DEC 08 contract is

$$100 - 97.705 = 2.295$$

which compares to the 2.23625 spot.

The contract works as follows: Suppose we bought one futures yesterday at the quoted settlement price of 97.805, implying a rate of $100 - 97.805 = 2.195$.

The CME Eurodollar futures has an underlying notional amount of 1M and is *marked-to-market*.

Marked-to-market means that the contract is settled daily. Since the underlying instrument is a 90 day interest rate, the long receives

$$-1,000,000 \times \left(2.295 \times \frac{90}{360} - 2.195 \times \frac{90}{360} \right) = -2,500 \times 0.1 = -250$$

from the short (the market is in zero net supply, so for every long there is a short).

ie. he pays 250.

Alternatively, we can say that the contract pays $25 \times$ basis point change in the underlying rate every day.

In other words, the DV01 of the Eurodollar futures is exactly 25 (wrt LIBOR). It does not depend on the level of interest rates, as do bond DV01s.

Advantages of the Eurodollar futures

- Speculation. We can bet on interest rate changes with with a notional 1M exposure with much smaller margin than 1M.
- We can easily bet on interest rate increases (short positions make money when LIBOR increases) without shorting bonds (or borrowing)
- Limited counter-party default risk because contracts are marked to market

Hedging interest rate risk

Consider a corporation which receives 100M on March 20th and invest the money again on June 19 (90 days later). The current Eurodollar rate is 2.274%.

The corporation buys 100 eurodollar futures.

On March 20th, the 90 day Eurodollar rate has changed to 2.75%.

The total cash flow from the futures contract is $250,000 \times (2.274 - 2.75) = -119,000$.

Next, the corporation invests 100 M at 2.75. The value of the investment is

$$100,000,000 \times \left(1 + \frac{2.75}{100} \times \frac{90}{360}\right) = 100,687,500$$

out of which the 687,500 is interest.

Note that if the corporation had invested at 2.274 they would have received interest of

$$100,000,000 \times \frac{2.274}{100} \times \frac{90}{360} = 568,500.$$

The difference,

$$687,500 - 568,500 = 119,000$$

is identical to the capital loss on the Eurodollar futures.

The difference between forwards and futures

Our previous computation completely ignores the difference in timing of the cash flows. A forward contract would have produced the loss of 119K at the settlement date of the forward.

A futures contract could in principle produce the entire 119K loss right after we enter into the contract.

The difference is a loss of 119 today (futures) vs a loss of 119 on March 20th.

Economically, losing 119 today is worse than losing it on March 20th, and the difference is an *interest-on-interest* effect.

The timing difference of the cash flows in forward and futures contracts has two implications

- The futures contract has (slightly) higher interest rate sensitivity. In hedging with futures therefore, one should buy slightly fewer futures contracts than forward contracts. Tuckman further details the adjustment on p. 344-47.
- Theoretical futures prices differ slightly from theoretical forward prices.

Consider, in the abstract, a futures contract written on a bond with maturity T that settles on date S . Let $F^u(t)$ denote the time t futures price

It is straightforward to show that the futures price must be equal to the expected future price of the T zero at time S using risk neutral probabilities to compute the expected value

$$F^u(0) = E^*(P(S, T)). \quad (1)$$

Tuckman also argues that the rate futures rate

$r_{fut} = 100 - F^u(0)$ is

$$r_{fut} = E^*(r_t) \quad (2)$$

where r_t is the future short rate. This holds if we interpret the future short rate to be the rate on a discount basis. In other words, if $P(S, T)$ is the time S price of a T maturity zero with \$100 face, and we define

$$r_t = 100 - P(S, T)$$

If we define the short rate in the usual manner (i.e.,

$r_t = (100/P(S, T))^{-\frac{360}{T-S}}$) then (2) will not hold.

Eurodollar Futures and Treasury Futures

Eurodollar futures are simply not treasury futures.

LIBOR rates are rates that contain a significant spread to similar maturity treasuries *because LIBOR rates contain significant counter-party default premiums.*

To model LIBOR futures rates, we need to consider the possible moves in both benchmark treasury rates, and the spread between libor and t-bill rates (default spread). We can accomplish this in a two factor model, by letting the first factor be the default free rate and the second being the spread, or the default probability. More on this in another class (on default risk).

The Fed fund futures market is similar to the LIBOR futures, except that

- The underlying is the 30 day effective Fed Fund rate (not the target rate)
- The notional amount is 5M
- The contract is settled to the *average* of the FF rate over the month
- Trades at the CBOT

Given the contract parameters, we have that the cash flow to a long FF futures receives

$$5,000,000 \times \frac{0.0001 \times 30}{360} = 41.67$$

per basis point change in the average FF rate.

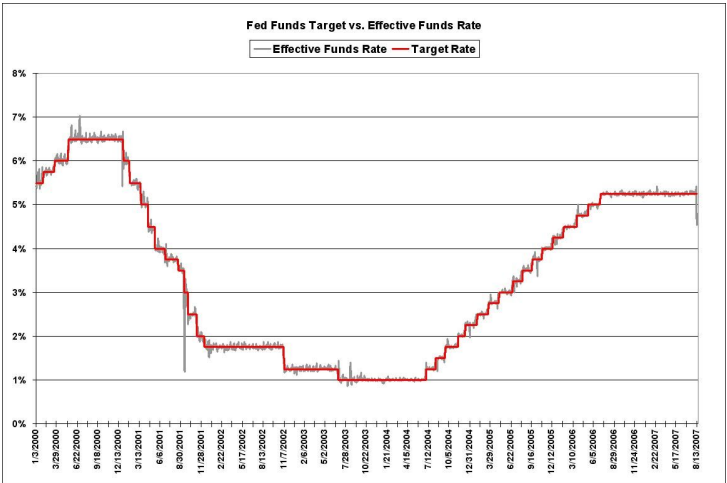


Figure: Target and effective Fed Funds rates.

As of Nov 14th, 2008, the FF futures traded at

	PRICE	RATE
NOV08	99.62	0.38
DEC08	99.54	0.46
MAR09	99.325	0.675
JUN09	99.195	0.805

As of Nov 14, 2008 the FF target rate is 1% while the effective rate 0.35%.

Betting on the FOMC

We will consider an example from the book on how to reverse engineer the markets expected Fed action from FF futures.

The following parameters apply:

- Current date is Dec 4, 2001.
- The current FF target is 2%.
- The average effective FF rate from Dec 1 to 4th was 2.025%.
- The next FOMC meeting is Dec 11th, 2001.
- The FF futures with settlement on Dec 31st, 2001 is trading at a rate of 1.845%

The 1.845 futures rate represents the expected, average rate from Dec 1st to Dec 31st of 2001. Let r denote the new FF target rate following the Dec 11 FOMC meeting.

We expect that the effective rate will equal the target rate from Dec 4-Dec 11, and also that the FF rate will not change following the meeting.

It must be that

$$1.845 = \frac{4 \times 2.025 + 7 \times 2 + 20E(r)}{31}$$

So we find the expected rate to be

$$E(r) = 1.766$$

Since this is lower than the current rate and close to a 25 basis point drop, we can guess that the probability of the target rate remaining unchanged is

$$2 \times p + (1 - p) \times 1.75 = 1.766$$

and we find $p = 0.064$ and $1 - p = 0.936$, implying that the market has puts a probability of about 94% on a 25 bp cut.

The Fed did indeed cut rates by 25 bp on Dec 11, 2001.

As of Jan 2015:

- Markets expect current near-zero interest rates to persist for several months
- Bump to 50 BP expected Oct/Nov 2015

See

<http://www.cmegroup.com/trading/interest-rates/stir/30-day-federal-fund.html>
for real time data.