8. Eurodollars: Parallel Settlement

Eurodollars are dollar balances held by banks or bank branches outside the country, which banks hold no reserves at the Fed and consequently have no direct access to settlement through Fedwire. Instead, Eurodollar balances settle on the private CHIPS network. The center of the world Eurodollar market is London, not New York.

Stigum provides an example of how Eurodollars arise when a US company Exxon transfers a deposit from Chase NY to Citibank London as follows (p. 212):

Exxon		Chase NY		Citi NY		Citi London	
A	L						
-10 Chase + 10 Citi London		-10 reserves	-10 Exxon	+10 reserves	+ 10 Citi London	+10 Citi NY	+10 Exxon

Because Citibank London has no account at the NY Fed, it holds instead an account at Citi NY which it uses to make and receive dollar payments. It accepts the deposit from Exxon by crediting its New York account (so expanding its balance sheet), and Citi NY accepts that deposit by expanding its holding of reserves at the New York Fed. When we talk about Eurodollars, we are talking about the balance sheet of Citi London.

Stigum makes a big deal of the point that in the process of creating Eurodollars no dollars leave the country. The balance sheets make clear that she is talking narrowly about reserve balances. From the point of view of the New York Fed, all that has happened is a debit from the account of Chase NY and a credit to the account of Citi NY, which leaves total reserve balances in the system unchanged. From another point of view however, the transaction does give rise to dollar balances held outside the country that used to be held inside. If the bank accepting the deposit was Credit Lyonnais rather than a branch of Citibank, we might see the point more clearly

Exxon		Chase NY		Citi NY		Credit Lyonnais	
A	L						
-10 Chase + 10 Credit Lyonnais		-10 reserves	-10 Exxon	+10 reserves	+ 10 Credit Lyonnais	+10 Citi NY +loans	+10 Exxon +deposits

If we confine our attention to the US, we see that there has been an expansion of the balance sheet of Citi NY but an exactly equal contraction of the balance sheet of Chase NY. However outside the US there has been an expansion of the balance sheet of Credit Lyonnais and no corresponding contraction. From a global perspective, there has been an expansion of credit.

And that is just the beginning. Since Credit Lyonnais has reserves in NY, it can now proceed to do dollar denominated banking business, both lending and deposit taking, outside the country.

Why is there a Eurodollar market? It seems to be a combination of two reasons. First, the dollar is an important (the most important) international currency, so people outside the US find themselves needing to make and receive payments in dollars. Since the payment system is a credit system, there is need for an interbank bank that links deficit and surplus agents, analogous to the Fed Funds market. In principle they could do it in NY, but that's where the second reason comes in.

Historically there were capital controls that got in the way of free movement of dollars in and out of the country, and there were regulatory controls (such as reserve requirements and FICA premiums for deposit insurance) on dollars held inside the country. The Eurodollar market sprang up to provide a necessary service outside the control of US authorities. Most of those barriers have by now been lifted, but the market survives as a separate entity.

But the Eurodollar market is more than a dollar payment system; it is also the world funding market. Wherever you may be in the world, if you need to raise money for some domestic project that you are unable to finance domestically, you are going to be borrowing in dollars. The picture to have in mind is these foreign banks taking deposits and making loans, essentially acting as money dealers in the global dollar market.

Borrower		Money Dealer		Depositor	
A	L	A	L	A	L
	Dollar loan	Dollar loan	Dollar deposit	Dollar deposit	

Apparently even now there is some advantage in having the institutions of the <u>international</u> dollar separate from the institutions of the <u>domestic</u> dollar. In fact, the overnight Eurodollar market has recently been larger in volume than the overnight Fed Funds market. (Not true during current credit crisis.) Which is the tail and which is the dog? Today, it is still the domestic dollar that dominates, but stay tuned (p. 860).

One issue to flag right away here is the question of monetary policy. The Fed is concerned about employment and inflation within the United States, and monetary policy is an attempt to influence those conditions. To do this, the Fed focuses attention on the domestic money supply and domestic interest rates, leaving largely out of consideration the international money supply in the Eurodollar market. The idea is that these balances are held by foreigners and so may influence their behavior, not by domestic consumers and businesses. Increasingly this is a difficult abstraction to defend, since important entities are global.

Eurodollar as interbank market

The fundamental reason for the Eurodollar market seems to be that foreign banks have customers who wish to hold dollar balances or take out dollar loans from them. This customer-led demand causes some of the banks to have a natural surplus position (more dollar deposits than loans) and other banks to have a natural deficit position (more dollar loans than deposits). They could each resolve the imbalance by doing business with some US bank, but it seems easier all around for them to do business with each other, with the surplus banks lending to the deficit banks. That's what is happening in the interbank market, and the London Interbank Offer Rate, or LIBOR, is the rate of interest charged in that market. Just so:

Deficit agent Citi London			Surplus agent Credit Lyonnais	
Assets	Liabilities		Assets	Liabilities
US$ customer loans	Eurodollar deposit, Credit		Eurodollar deposit, Citi	US$ customer deposits

Both Citi and Credit seek "matched book", which means that their dollar liabilities are the same as their dollar assets, since that protects them from any change in the value of the dollar. Because their natural customer positions offset, they can achieve matched book by trading with each other in the interbank market. This is an unsecured interbank borrowing like Fed Funds, and like in the Fed Funds market banks control the counterparty risk by controlling their credit lines to one another. (Tiering of prices is apparently not about credit risk, but more about market organization.)

It is not enough however simply to match total assets and total liabilities. Especially so when we have in mind the special vulnerability of the Eurodollar market to liquidity problems because of its lack of access to the Fed's balance sheet. The liquidity of the Eurodollar market ultimately depends on the ability and willingness of the New York banks to provide liquidity as needed by taking the problems of the Eurodollar market onto their own balance sheets. Uncertainty about that ability and willingness makes the Eurodollar banks take care to line up the <u>time pattern</u> of cash inflows and cash outflows, in order to minimize their need to use reserves. That's the reason that Eurodollar deposits are made to specific dates, with no early withdrawal permitted (and no negotiability of the deposit either). The bank wants to know precisely when the cash outflow will happen, in order to prepare to meet it. But what if those dates don't line up?

Balance Sheet Approach to FRA

The most important instrument for that purpose is the Forward Rate Agreement, which I will now proceed to explain. It is an <u>off-balance sheet</u> instrument, essentially a side bet on the value of LIBOR at some date in the future, but we understand its importance better if we imagine what it would look like as an <u>on-balance sheet</u> instrument. This mode of analysis, which we'll be using for all derivatives, is presented here for the first time, so it is worth your while to master it.

Suppose that two months from now Bank X expects to be making a 3-month US$ loan, and two months from now Bank Y expects to be receiving a 3-month US$ deposit. (Perhaps these expectations arise from existing loans and deposits that expire in two months but which the customer is likely to renew, see p. 832). They can help each other line up cash flows in time by swapping IOUs today as follows:

Bank X (forward borrower) Bank Y (forward lender)

2 month deposit, F%	5 month deposit, F%		5 month deposit, F%	2 month deposit, F%

At the moment, suppose these two IOUs have exactly the same value, so no money changes hands. Also, over the next two months the interest rate is the same, so again no money changes hands. But two months from now one deposit matures, which involves a cash flow from Bank Y to Bank X. X uses it to make a loan, Y uses it to invest a deposit. Five months from now the other deposit matures, which involves a cash flow from Bank X to Bank Y.

Observe that this pattern of cash flows is exactly what the banks need in order to hedge their natural positions. Two months from now Bank Y gets a customer deposit, and pays it to Bank X, which uses it to make a customer loan. Five months from now the customer repays the loan to Bank X, which sends the money to Bank Y. At the end of the day, it is the three month deposit that funds the 3 month loan, but the on-balance sheet IOUs allowed the banks to set it up ahead of time.

Bank X			Bank Y	
3 month loan	3 month deposit, F%		3 month deposit, F%	3 month deposit,

So we could do all of this with an explicit swap of IOUs on balance sheet, but we don't. Banks are always looking to economize on balance sheet capacity, and there is a more efficient way to get the same job done. For a while banks did something almost like a swap of IOUs, called a forward forward, where Bank Y agreed in advance to place a 3 month deposit in Bank X at rate F% two months from now. Clearly, this forward forward structure just nets out the first two months of our ideal on-balance sheet swap of IOUs.

The Forward Rate Agreement goes even farther by netting out the principal that is paid from Y to X in two months, and back again the other way in five months. Instead what is paid is the difference between LIBOR and F% two months from now. (See p. 832 for a worked example.) It is because these principal payments have been eliminated that FRA agreements can be off-balance sheet agreements. Bank X plans to fund the loan by borrowing at LIBOR, and Bank Y plans to invest its deposit by lending at LIBOR. But by engaging in a FRA that pays the difference between LIBOR and F%, they both manage to lock in an interest rate of F% for the funds in question. Bank X doesn't care how high LIBOR might go, and Bank Y doesn't care how low LIBOR might go, <u>just so long as the liquidity is there so they can raise and invest the principal amounts as needed</u>. (I underline this last bit, since it is a key assumption, almost always satisfied but likely to fail when you need it most.)

Bank X Bank Y

3 month loan	3 mo deposit, LIBOR% 3 mo deposit, (F%-LIBOR%)		3 mo deposit, LIBOR% 3 mo deposit, (F%-LIBOR%)	3 mo deposit

Forward Interest Parity

Turn now to the question of what rate F% is appropriate for this transaction. Whatever rate it is, the effect is to lock in the cost of funding the future loan, and the benefit from accepting the future deposit, so both banks have an interest in getting the number right. Bank X would like a low number, and Bank Y would like a high number. What number will be chosen?

The answer depends on something called Forward Interest Parity. Suppose there is a **market** rate for 2-month deposits (2 month LIBOR) and a **market** rate for 5-month deposits (5 month LIBOR). If you were long one of these and short the other, you would have locked in a 3 month borrowing/lending rate for two months from now, and the rate you lock in can be calculated as follows:

FIP: $[1+R(0,N)][1+F(N,T)] = [1+R(0,T)]$

The notation is that R(0,N) is the rate of interest on a deposit extending from now to N (2 months in our example), R(0,T) is the rate of interest on a deposit extending from now to T (5 months in our example) and F(N,T) is the implied forward rate on a three month deposit two months from now.[1]

FIP is an **arbitrage condition**. What that means is that if the actual forward rate on a FRA were any different from the implied forward rate, there would be opportunities for riskless profit by lending at the higher rate and borrowing at the lower rate. Because of this, in practice the market forward rate tends to be very close to the implied forward rate. This is the rate that will be chosen for our interbank transaction.

Eurocurrencies and FX swaps

In addition to the Eurodollar market that trades at US$ LIBOR, there are also Euro markets in other major currencies such as the euro, the pound sterling, and the yen. The existence of these other markets provides yet another degree of freedom for bankers looking to line up cash inflows and outflows. (If the desired timing is not available in one currency, perhaps it is available in another currency.) However, if we go that route, then have a different <u>problem of mismatch in our currency exposure</u>. That is the problem

[1] I follow G. Poitras.

that gives rise to the foreign exchange swap, which permits banks to trade out of any currency mismatch they may have.

The book talks about a Euroyen swap. Let us think about what that swap would look like as an on-balance sheet operation, and use that to help us understand what is going on. Suppose a bank commits to lend 6-month Euroyen and now needs to fund that loan (p. 855). Suppose that funds are available in 6-month Eurodollars, so now the bank has a problem of currency mismatch. Six months from now it will be receiving yen (from the loan) and paying out dollars (on the deposit). How can it fix that mismatch?

It can solve that problem with the following balance sheet operation:

Bank			Counterparty	
Assets	Liabilities		Assets	Liabilities
6 month loan, Euroyen	6 month deposit Eurodollars			
6 month deposit, R Eurodollars	6 month deposit, R* Euroyen		6 month deposit, R* Euroyen	6 month deposit, R Eurodollars

Observe that this balance sheet operation leaves our bank with completely matched book, both over time and across currencies. Six months from now it will be receiving yen (from the loan) and paying out yen (on the swap), and receiving dollars (on the swap) and paying dollars (on the deposit).

Let us now suppose that this swap of IOUs has zero value at inception and investigate the details that would make it so. First step is to open accounts that have the same current value according to the current exchange rate, say 115 yen for every dollar, S(0). (Note well that I am defining the exchange rate as yen/dollar, so a rise in S is an appreciation of the dollar and a depreciation of the yen.) Six months from now we'll close the accounts and there will be a different exchange rate, but we can fix a notional rate F(T) today that makes the present value of the two accounts exactly the same. Here's how.

Today there is some prevailing interest rate for Euroyen, R*, and some prevailing interest rate for Eurodollars, R. So if we open a Euroyen account with 115 yen it will grow by the rate R*, and our $1 Eurodollar account will grow by the rate R. These accounts would have the same value six months from now if the exchange rate changed by exactly the right amount to counter the interest rate differential. The future exchange rate that makes these two accounts have the same value today is the exchange rate F(T) that satisfies Covered Interest Parity

CIP: $$[1+R^*(0,T)]S(0) = [1+R(0,T)]F(T)$$

The left hand side is the yen value of the yen account at maturity, and the right hand side is the yen value of the dollar account at maturity. Like FIP, CIP is an arbitrage condition, so we expect the actual market forward exchange rate to be very close to the forward exchange rate that is implied by this formula, and it usually is.

The cash flows involved in our notional swap of IOUs are as follows:

Time 0: $1 from Bank to counterparty, S(0) yen from counterparty to bank
Time T: [1+R*]S(0) yen from bank to counterparty, [1+R] dollars from counterparty to bank

If the actual exchange rate S(T) = F(T) [=(1+R*)S(0)/(1+R)] then the cash flows at time T are exactly offsetting in value terms. But if S(T) > F(T) then a dollar buys more yen, so the cash inflow to the bank (from the swap) is worth more than the cash outflow (from the swap). And if S(T) < F(T) then a dollar buys less yen, so the cash inflow to the bank is worth less than the cash outflow.

Now we can see how to do the same thing more efficiently with a swap. A swap contract is nothing more than an off balance sheet way of achieving the exact same net cash flows as the on-balance sheet swap of IOUs. At time 0, the two parties swap yen for dollars at S(0) and agree to swap back again at F(T). (In the case of the FX swap, these principal payments cannot be netted because they are in different currencies, and that is different from the forward interest swap.)

The effect of the FX swap is to shield the bank from any fluctuation in the yen exchange rate. If the yen falls in value, he loses on his Euroyen loan but gains on the offsetting swap. If the yen rises in value, he gains on his Euroyen loan but loses on the offsetting swap. The bank does not care what happens to the yen exchange rate.

EH and UIP—Two relationships that you might think should be true but aren't

The Expectations Hypothesis of the term structure suggests that the forward rate should be equal to the expected future spot rate, and this sounds like a reasonable theory. In practice however there tends to be an inequality.

EH: F(N,T) = ER(N,T)

Violation of EH: F(N,T) > ER(N,T)

What this means is that Bank X typically would have done better by not engaging in the FRA and simply borrowing funds as needed in the spot market. That Bank X is willing to lose this money tells us that it is paying for insurance. Note that it is the borrower of money who pays, not the lender. This violation of EH is another symptom of the hierarchy of money and credit.

Similarly, since the forward exchange rate can be locked in today, we might expect it to bear some relationship to the expected future exchange rate. Uncovered Interest Parity suggests that they should be equal, and this sounds eminently reasonable.

UIP: $F(T) = ES(T)$, or, using the CIP relationship

$$(1+R^*)/(1+R) = ES(T)/S(0)$$

Suppose $R^*<R$, so the yen is a relatively low yielding currency. UIP says that we must expect the dollar to depreciate against the yen (yen to appreciate against the dollar) by just enough to make both currencies have the same yield, at least ex ante.

Nice theory, but unfortunately it seems not to hold up very well in the real world. Study after study finds

Violation of UIP: If $F(T) < S(0)$, [i.e. $R>R^*$], then $F(T) < ES(T)$

That is to say, usually the low yielding currency does not appreciate by enough to give it the same yield as the high yielding currency. (In fact, typically the low yielding currency actually depreciates, contrary to UIP prediction that it will appreciate.)