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Recent Developments in U.S. Dollar Funding Costs through FX Swaps

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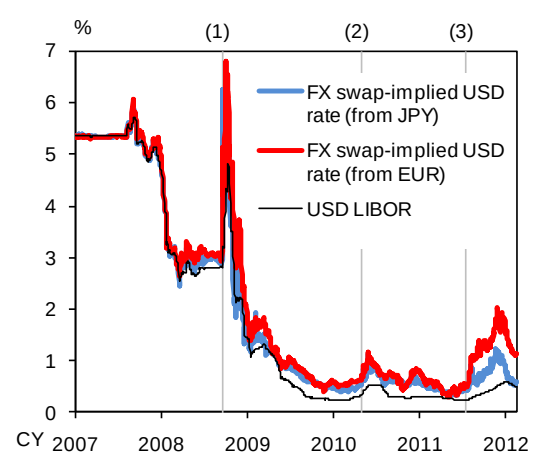
Since the summer of 2011, foreign exchange (FX) swap-implied U.S. dollar rates have attracted attention amid a growing concern over European banks' dollar funding. In this paper, we analyze the dollar rate based on interest arbitrage and clarify the factors affecting its fluctuation. The main results of the analysis are as follows. (1) From mid-July to late October 2011, the FX swap-implied dollar rate from the euro rose under increasing stress observed in the unsecured euro and dollar markets. (2) From November, the rate soared to a level not fully explained by the observed stress in the unsecured markets, implying a very tight dollar funding situation in the FX swap market. (3) Subsequently, the rate started to decline and showed that stress in the FX swap market had eased, as the year-end had passed without a problem given the coordinated central bank action to lower the interest rates on the dollar funds-supplying operations.

Introduction

Since the summer of 2011, international financial markets have been unstable, with a major reason for market volatility being a growing concern over U.S. dollar funding by European banks that hold dollar-denominated assets in their portfolios. Under normal conditions, even financial institutions that lack a strong dollar-denominated retail deposit base can use several measures for raising dollars: through unsecured transactions such as issuing certificates of deposit (CDs) or offshore (Eurodollar) market transactions, as well as secured transactions. However, counterparty risk has become a major concern because of the European sovereign debt problem, and this has restricted unsecured funding and forced the institutions to shift to secured transactions.

When non-U.S. banks raise U.S. dollars through secured transactions, they often use an FX swap to exchange their domestic currency for dollars. An FX swap is a contract to undertake FX spot and forward transactions simultaneously in a reverse direction. For example, banks in the euro area can raise dollars for a certain period by selling euros to buy dollars in the spot market and selling dollars to buy back euros in the forward market, as long as they have euros on hand that are relatively easy to raise. As these transactions can be considered as funding of dollars by providing the domestic currency (the euro) as collateral, it is easy for non-U.S. banks to undertake them even if their funding in the unsecured dollar market becomes restricted.

Chart 1: FX Swap-Implied U.S. Dollar Rate (3-Month)



Note: (1) The Lehman shock (September 15, 2008). (2) Greece officially requested assistance from the EU and the IMF (April 23, 2010). (3) The Italian 10-year bond yield reached 6 percent for the first time since the introduction of the euro (July 12, 2011).
Source: Bloomberg.

European banks appear to depend heavily on U.S. dollar funding through FX swaps, while U.S. money market funds (MMFs) have been reluctant to accept European banks' CDs since the summer of 2011. Thus,

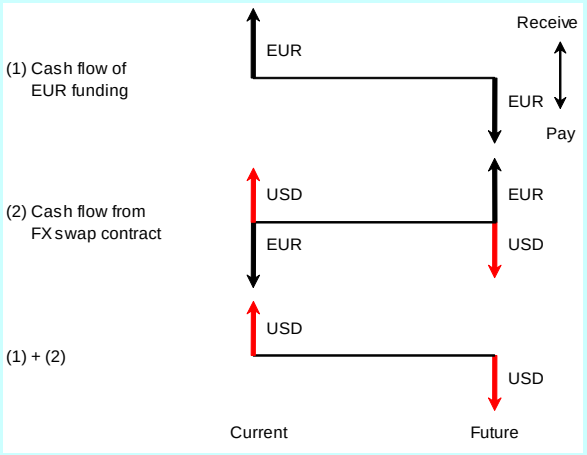
it is no surprise that the FX swap market has attracted attention in terms of assessing the market stress or sustainability of dollar funding. In particular, an FX swap-implied dollar rate is thought to provide important information in this regard. In fact, in prior periods when market stress increased and unsecured funding became restricted, the rate rose to a much higher level than the unsecured benchmark rate (dollar LIBOR) (Chart 1). This paper focuses on the FX swap-implied dollar rate, clarifies the factors affecting its fluctuation, and examines the background up to now.

Components of FX Swap-Implied U.S. Dollar Rates

Mechanism of funding U.S. dollars through the FX swap market

Before discussing the components of an FX swap-implied U.S. dollar rate, let us briefly observe what dollar funding through FX swaps looks like. For banks in the euro area, for example, dollar funding through FX swaps consists of two transactions: (1) euro funding and (2) an FX swap contract between euros and dollars (Chart 2). In economic terms, these transactions are considered to be borrowing dollars by using the raised euros as collateral.

Chart 2: Cash Flows of U.S. Dollar Funding through an FX Swap



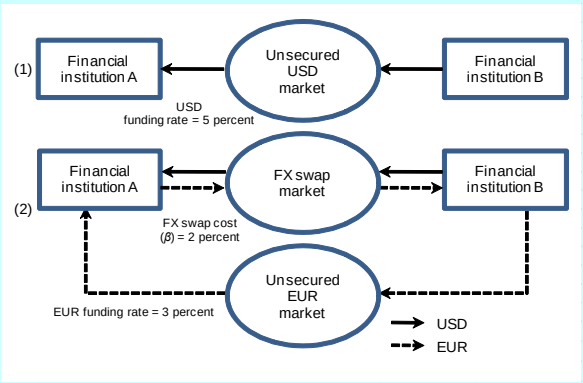
Components of FX swap-implied U.S. dollar rates

U.S. dollar funding through FX swaps is the combination of raising the domestic currency and an FX swap contract as shown above. Therefore, the FX swap-implied dollar rate from the euro, for example, can be expressed as the following:[1]

FX swap-implied USD rate from EUR
= EUR funding rate + FX swap cost (β).

How is β determined? First, let us imagine a case where no counterparty risk exists and all financial institutions can access the unsecured markets as well as the FX swap market. Then, β will converge to the interest spread between the unsecured U.S. dollar and euro markets, and the FX swap-implied dollar rate from the euro will become equal to the dollar funding cost in the unsecured dollar market. This can be explained in the following using Chart 3. A financial institution that intends to raise dollars (financial institution A in Chart 3) will compare (1) the dollar funding cost in the unsecured dollar market with (2) the total cost of raising euros in the unsecured euro market and converting them into dollars through an FX swap transaction, and choose the lower-cost measure. Conversely, a financial institution that intends to invest dollars (financial institution B in Chart 3) will compare (1) the return in the unsecured dollar market with (2) the total return of converting dollars into euros through an FX swap transaction and investing euros in the unsecured euro market, and choose the higher-return measure. Arbitrage from both the dollar raising and investing sides will equalize the funding costs (or returns) of (1) and (2), and β will converge to the interest spread between the unsecured dollar and euro markets.[2]

Chart 3: How β Is Determined under Normal Conditions



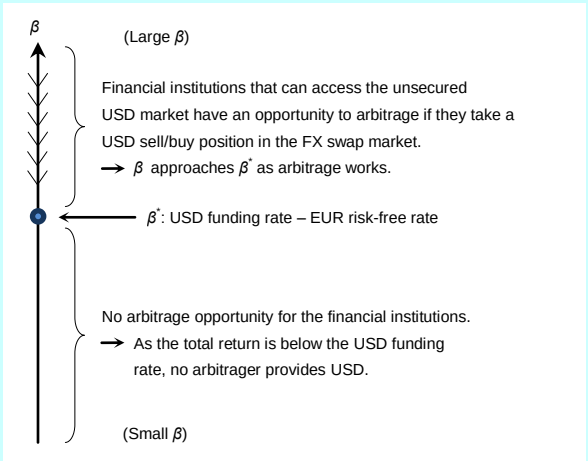
Next, let us consider the case where counterparty risk is a concern, and some financial institutions such as financial institution A in Chart 3 cannot access the unsecured U.S. dollar market. As financial institution A only has (2) to raise dollars, dollar funding pressure increases in the FX swap market. Financial institution B, on the other hand, can invest its dollars in both measures. However, financial institution B will become more cautious about providing dollars,

because counterparty risk is a concern and both measures involve investing in the unsecured markets with credit risk. This results in upward pressure on β, and the FX swap-implied dollar rate from the euro increases more than the funding rate through the unsecured dollar market. How much β increases depends mainly on the degree to which counterparty risk is a concern. However, if β is large enough to satisfy the following inequality,

USD funding rate $< \beta +$ *EUR risk-free rate*,

it is possible in theory for the financial institutions that can access the unsecured dollar market and become dollar providers in the FX swap market to arbitrage through the mechanism explained below. That is, if the funding cost in the unsecured U.S. dollar market is less than the sum of β and the return from investing euros obtained through an FX swap in a euro risk-free asset (which is insulated from counterparty risk), then it is possible for financial institutions that sell dollars in the spot market and buy them in the forward market (a dollar "sell/buy" position in FX swaps) to arbitrage by means of the combination of dollar funding in the unsecured market, an FX swap contract, and investment in a euro risk-free asset. In what follows, let us define β^* as β's benchmark that equalizes the left- and right-hand sides of the above inequality, and α as the difference between β and β^* (Chart 4):

Chart 4: Arbitrage Opportunity for Financial Institutions That Take a U.S. Dollar Sell/Buy Position in the FX Swap Market



$$\beta^* = \textit{USD funding rate} - \textit{EUR risk-free rate}$$
$$\beta = \beta^* + \alpha$$
$$= \textit{USD funding rate} - \textit{EUR risk-free rate} + \alpha.$$

Conceptually, α is an indicator that shows whether an arbitrage opportunity remains for the financial institutions that take a U.S. dollar sell/buy position in the FX swap market.[3] A large positive value of α implies that liquidity in the FX swap market is low, and the dollar funding situation in the FX swap market is tight.[4]

These results enable us to decompose the FX swap-implied U.S. dollar rate from the euro as follows:[5]

$$\begin{aligned}&\textit{FX swap-implied USD rate from EUR}\\ &= \textit{EUR funding rate} + \beta\\ &= \textit{EUR funding rate} + \textit{USD funding rate}\\ &\qquad - \textit{EUR risk-free rate} + \alpha\\ &= \textit{USD risk-free rate}\\ &\quad + (\textit{USD funding rate} - \textit{USD risk-free rate})\\ &\quad + (\textit{EUR funding rate} - \textit{EUR risk-free rate})\\ &\quad + \alpha.\end{aligned}$$

To replace the funding rate and the risk-free rate with LIBOR and OIS, respectively, for both the U.S. dollar and the euro,[6]

$$\begin{aligned}&\textit{FX swap-implied USD rate from EUR}\\ &= \textit{USD OIS} + (\textit{USD LIBOR} - \textit{USD OIS})\\ &\qquad + (\textit{EUR LIBOR} - \textit{EUR OIS}) + \alpha.\end{aligned}$$

That is, the FX swap-implied U.S. dollar rate from the euro consists of four factors: (1) a forecast of the U.S. policy rate (dollar OIS); (2) observed stress in the unsecured dollar market (dollar LIBOR minus dollar OIS); (3) observed stress in the unsecured euro market (euro LIBOR minus euro OIS); and (4) residual dollar funding pressure unique to the FX swap market (α). In the next section, we decompose the FX swap-implied dollar rates from both the euro and the yen into these four factors, and examine their background.

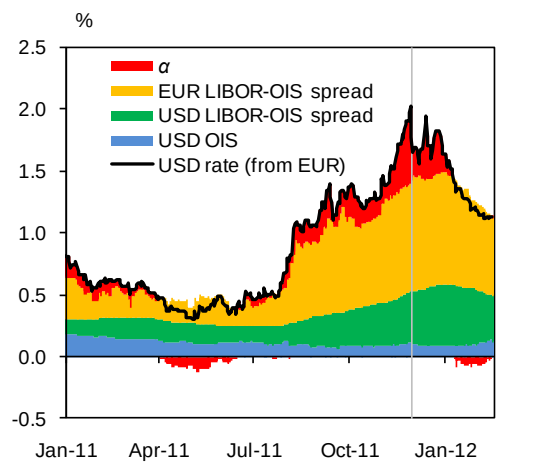
Decomposition of FX Swap-Implied U.S. Dollar Rates

Decomposition of the FX swap-implied U.S. dollar rate from the euro

Chart 5 shows the breakdown of the 3-month FX swap-implied U.S. dollar rate from the euro since the beginning of 2011. While relatively stable until early July 2011, the dollar rate rose along with the expansion of the euro and dollar LIBOR-OIS spreads (particularly the euro LIBOR-OIS spread) from mid-July to late October. In other words, the dollar rate was pushed upward by the increasing concern over counterparty risk observed in the unsecured markets because of the European sovereign debt problem. From November, on the other hand, α

contributed a great deal to the rapid increase in the dollar rate in addition to the expansion of the euro and dollar LIBOR-OIS spreads. This was because (1) the potential dollar providers grew more cautious with the approach of the year-end, and (2) the financial institutions with restricted access to unsecured dollar funding became more aggressive in funding through FX swaps in order to meet their year-end liquidity demand. The increase in α implies that the dollar funding situation in the FX swap market became increasingly tighter.[7]

Chart 5: Breakdown of the FX Swap-Implied U.S. Dollar Rate from the Euro

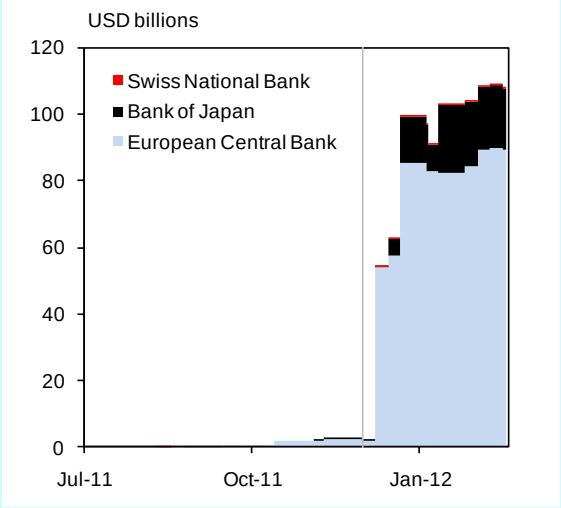


Note: 3-month. The U.S. dollar rate (from the euro) is the FX swap-implied dollar rate from the euro. The vertical line is the date when the central banks decided to lower the rates on the dollar funds-supplying operations (November 30, 2011).
Source: Bloomberg.

In these circumstances, the Federal Reserve, the European Central Bank (ECB), the Bank of England, the Bank of Canada, the Swiss National Bank, and the Bank of Japan announced on November 30 a lowering of the rates on the U.S. dollar funds-supplying operations by 50 basis points, so that the new rate became the dollar OIS plus 50 basis points. Previously, financial institutions, especially those in Europe, had not used the operations very often for fear of a stigma attached to applying for such operations. Following the coordinated central bank action, however, the amount outstanding of the dollar funds-supplying operations rose substantially, while economic incentives for bidding increased (Chart 6).

In the meantime, the FX swap-implied U.S. dollar rate from the euro temporarily dropped along with the decrease in α because the dollar funding pressure on the FX swap market eased just after the coordinated central bank action. Until the year-end, however, the rate rose and fell repeatedly while the potential dollar providers in the FX swap market remained cautious

Chart 6: Amount Outstanding of U.S. Dollar Supplying Operations



Note: The vertical line is the date when the central banks decided to lower the rates on the U.S. dollar funds-supplying operations (November 30, 2011).
Sources: Central banks.

about providing dollars. Since the turn of the year, the rate has clearly declined with the decrease in α again, and also because the year-end passed without a problem. α is currently around zero, which presents no arbitrage opportunity (to invest in a risk-free asset) for the potential dollar providers in the euro/dollar FX swap market. In addition, the euro LIBOR-OIS spread narrowed after the ECB offered a three-year longer-term refinancing operation in late December, and the dollar LIBOR-OIS spread has also declined slightly. Such a receding concern over counterparty risk in the unsecured markets has also contributed to the current decrease in the FX swap-implied dollar rate from the euro.

Decomposition of the FX swap-implied U.S. dollar rate from the yen

We can decompose the FX swap-implied U.S. dollar rate from the yen in the same way:

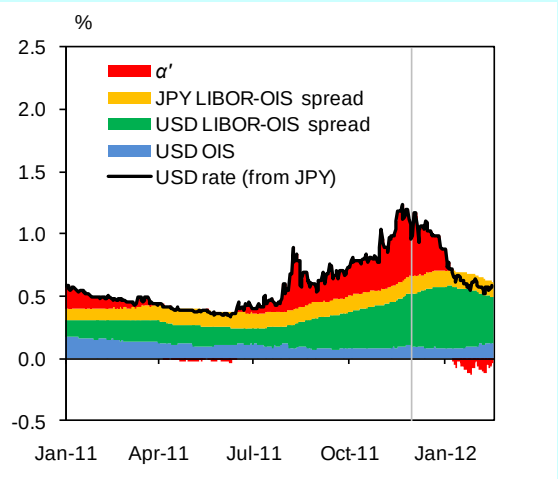
$$\begin{aligned} &\textit{FX swap-implied USD rate from JPY} \\ &= \textit{USD OIS} + (\textit{USD LIBOR} - \textit{USD OIS}) \\ &\qquad + (\textit{JPY LIBOR} - \textit{JPY OIS}) + \alpha'. \end{aligned}$$

Based on the above expressions, let us observe the breakdown of the 3-month FX swap-implied U.S. dollar rate from the yen since the beginning of 2011 (Chart 7). The dollar rate rose from mid-July to late November along with the expansion of the dollar LIBOR-OIS spread and the increase in α'. Meanwhile, the yen LIBOR-OIS spread remained more or less flat, and did not put upward pressure on the dollar rate.

This contrasted sharply with the dollar rate from the euro, which rose with the expansion of the euro LIBOR-OIS spread. Following the coordinated central bank action, the dollar rate from the yen declined with the decrease in α', as did the dollar rate from the euro. α' currently falls into negative territory. Therefore, here too there is no arbitrage opportunity (to invest in a risk-free asset) for the potential dollar providers in the dollar/yen FX swap market.

Around early August and late October last year, when the Japanese government intervened in the FX market by selling yen on a large scale, α' soared temporarily. This occurred because U.S. dollar tightness in the FX swap market strengthened rapidly as dollars were absorbed by the government's intervention.

Chart 7: Breakdown of the FX Swap-Implied U.S. Dollar Rate from the Yen



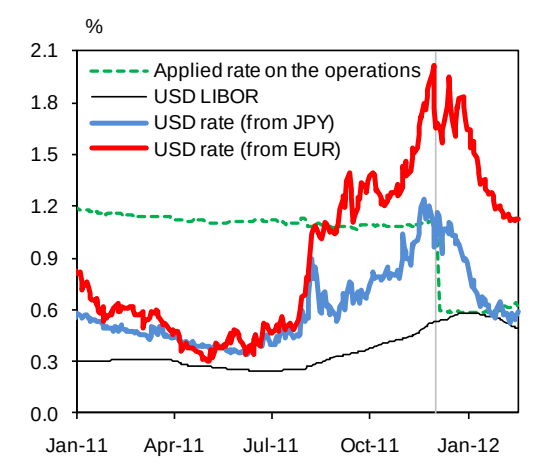
Note: 3-month. The U.S. dollar rate (from the yen) is the FX swap-implied dollar rate from the yen. The vertical line is the date when the central banks decided to lower the rates on the dollar funds-supplying operations (November 30, 2011).
Source: Bloomberg.

Conclusion

This paper focused on the FX swap market broadly used as a U.S. dollar funding measure with collateral. We analyzed the FX swap-implied dollar rates based on interest arbitrage, and clarified the factors affecting their fluctuations. The results of the analysis show that (1) when the dollar supply and demand situation tightens, a growing concern over counterparty risk observed in the unsecured markets (i.e., the widening of LIBOR-OIS spreads) should cause an increase in the FX swap-implied dollar rate. (2) Moreover, regarding the FX swap-implied dollar rate from the euro, for example, the developments in the euro LIBOR-OIS spread as well as the dollar LIBOR-OIS spread are important. (3) In addition, the FX swap-implied dollar rate sometimes soars to a level not fully explained by the observed stress in the unsecured markets when the dollar supply and demand situation becomes extremely tight. It is important to keep these points fully in mind when monitoring these markets.

Following the recent coordinated central bank action, the FX swap-implied U.S. dollar rates from both the euro and the yen have declined, implying that the funding conditions of dollars through FX swaps have eased; another reason for the decline is that the year-end passed without a problem. Nevertheless, the FX swap-implied dollar rate from the euro is still much higher than the dollar LIBOR or the interest rates on the dollar funds-supplying operations (Chart 8). If we assume that dollar funding pressure on the FX swap market remains strong, then for a further decrease in the dollar rate to occur it seems necessary that concerns over counterparty risk in the unsecured markets (i.e., the euro and dollar LIBOR-OIS spreads) recede further.[8]

Chart 8: FX Swap-Implied U.S. Dollar Rate and Interest Rate on Dollar Funds-Supplying Operations



Note: 3-month. The applied rate on the operations is the rate on the U.S. dollar funds-supplying operations. It is calculated as dollar OIS plus 100 basis points until December 2, 2011 and dollar OIS plus 50 basis points from December 5. The dollar rate (from the euro or the yen) is the FX swap-implied dollar rate. The vertical line is the date when the central banks decided to lower the rates on the dollar funds-supplying operations (November 30, 2011).
Source: Bloomberg.

Box: Arbitrage Conditions for FX Swaps

The FX swap-implied U.S. dollar rate from the euro is the sum of the costs of raising euros in the unsecured market and exchanging euros for dollars through FX swaps. Hence, it is expressed as the following:

$$\textit{FX swap-implied USD rate from EUR} = \textit{EUR funding rate} + \textit{FX swap cost}\ (\beta).$$

After replacing the funding rate and the risk-free rate with LIBOR and OIS, respectively, let us consider arbitrage transactions that invest in risk-free assets from both sides: that is, investors who take U.S. dollar sell/buy and buy/sell positions in the FX swap market. Then, we can derive the following non-arbitrage condition regarding β:[9]

$$\textit{USD OIS} - \textit{EUR LIBOR} \leq \beta \leq \textit{USD LIBOR} - \textit{EUR OIS}.$$

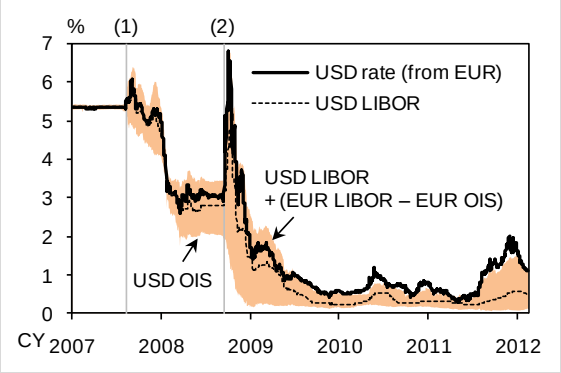
Therefore, the FX swap-implied U.S. dollar rate from the euro, which is the sum of the euro LIBOR and β, will be determined in the following range:

$$\textit{USD OIS} \leq \textit{FX swap-implied USD rate from EUR} \leq \textit{USD LIBOR} + (\textit{EUR LIBOR} - \textit{EUR OIS}).$$

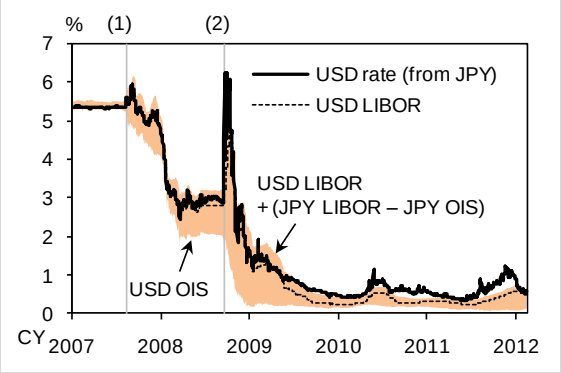
If counterparty risk is not a concern in the unsecured U.S. dollar and euro markets, and the LIBOR-OIS spreads are zero, then the left-hand side coincides with the right-hand side in terms of the above non-arbitrage condition regarding the dollar rate. Hence, the dollar rate will be determined at a specified level equal to the dollar LIBOR (and the dollar OIS) if interest arbitrage works. Conversely, this holds only in the very specialized case in which markets are completely stable. When counterparty risk is a concern, the dollar rate is not determined automatically at a specified level even if interest arbitrage is likely to work well. Where in the non-arbitrage range the dollar rate is determined depends on the relative tightness of the dollar and euro supply and demand situation in the markets.

Box Chart 1 shows the FX swap-implied U.S. dollar rate from the euro and its non-arbitrage range (with the lower limit as the dollar OIS and the upper limit as the dollar LIBOR plus the euro LIBOR-OIS spread) since 2007. We noted the following. (1) The range widened significantly, following the BNP Paribas shock in August 2007. (2) Furthermore, after the Lehman shock in September 2008, the dollar rate remained close to or above the upper limit, implying that the demand for funding dollars was relatively strong compared to euros. The FX swap-implied dollar rate from the yen follows a similar pattern (Box Chart 2).

Box Chart 1: FX Swap-Implied U.S. Dollar Rate (from the Euro)



Box Chart 2: FX Swap-Implied U.S. Dollar Rate (from the Yen)



Note: 3-month. The U.S. dollar rate (from the euro or the yen) is the FX swap-implied dollar rate. (1) The BNP Paribas shock (August 9, 2007). (2) The Lehman shock (September 15, 2008).
Source: Bloomberg.

[1] Here we explain the FX swap-implied U.S. dollar rate from the euro. If we consider the FX swap-implied dollar rate from other currencies, we can merely replace the euro with other currencies.

[2] The FX swap is traded using the spread of the FX forward rate and the FX spot rate (forward spread). The FX swap cost (β) shown in this paper is the annualized rate of the forward spread (more precisely, it is calculated as the annualized forward spread divided by the FX spot rate). β includes an implied interest spread between currencies. Here we show its derivation from covered interest parity (CIP), but this will not affect understanding of the paper even if the following is skipped.

Let us consider the euro/U.S. dollar FX swap. Then CIP shows

$$1 + \frac{F - S}{S} = \frac{1 + USD \times d / 360}{1 + EUR \times d / 360}.$$

F denotes the FX forward rate, S is the FX spot rate, USD is the implied U.S. dollar rate, and EUR is the implied euro rate. Taking the natural logarithm of both sides leads to the following. That is, β can be considered as an implied interest spread between currencies:

$$\frac{F - S}{S} \times \frac{360}{d} (= \beta) \approx USD - EUR.$$

Note that $\ln(1 + x) \approx x$ if x is near zero. If β coincides with the observed interest spread in the market such as the LIBOR spread between currencies, the FX swap-implied U.S. dollar rate from the euro (which consists of the euro funding rate and β) coincides with the dollar rate (i.e., the dollar LIBOR). However, Chart 1 shows that the current FX swap-implied dollar rate from the euro is higher than the dollar LIBOR, and β is larger than the LIBOR spread (i.e., dollar LIBOR minus euro LIBOR). This difference between β and the LIBOR spread is called the FX swap basis cost. For more information about the FX swap basis cost, see Linda S. Goldberg, Craig Kennedy, and Jason Miu, "Central Bank Dollar Swap Lines and Overseas Dollar Funding Costs," *Economic Policy Review,* Federal Reserve Bank of New York, 2011.

[3] α differs conceptually from the FX swap basis cost shown in Footnote 2. Subtracting the spread between the euro funding rate and the euro risk-free rate from the basis cost determines α.

[4] There are several potential explanations of why the residual (α) not accountable from the standpoint of interest arbitrage could emerge, as follows. (1) Under the low liquidity in the U.S. dollar unsecured market, arbitragers might be unable to reserve sufficient amounts of dollars for arbitrage transactions. (2) There should also be additional counterparty risk that does not appear in the interest rate market. There might also be (3) transaction costs and (4) measurement errors. Regarding (4), the LIBOR fixing rate, for example, is based on the rates reported by several specified banks and is not an individual market rate; consequently, it includes certain measurement errors.

[5] Here, we only consider a non-arbitrage condition for the investors who take a U.S. dollar sell/buy position in the FX swap market in light of the present situation where dollar funding needs are relatively strong. The non-arbitrage condition for both sides -- investors who take dollar sell/buy and buy/sell positions -- is considered in the Box.

[6] OIS is a type of interest rate swap that exchanges floating against fixed rates, using overnight rates as floating. For details, see Eiko Ooka, Teppei Nagano, and Naohiko Baba, "Recent Development of the OIS (Overnight Index Swap) Market in Japan," Bank of Japan Review Paper No. 2006-E-4, 2006. We use OIS as a risk-free rate in this paper, but it is also possible to use Treasury bill yields instead. In such a case, LIBOR-OIS spreads change to TED spreads, but they are similar in the sense that both of them measure stress in the unsecured markets.

[7] Another potential reason why α (and hence the FX swap-implied U.S. dollar rate from the euro) increased is a concern over the FX swap itself. The FX swap is a type of secured transaction, but some investors might be cautious about the costs, for example, of disposing of collateral in case of counterparty default, and accordingly might demand reasonable risk premiums for FX swap transactions. However, in light of the fact that α' in the dollar/yen FX swap market increased almost coincidentally -- as we will discuss later -- but investors did not become cautious about Japanese banks' dollar funding at that time, the increase in α should more accurately reflect (1) and (2) shown in the context.

[8] Note that the FX swap-implied U.S. dollar rate from the euro can decrease with α falling into negative territory if euro funding needs not intended for arbitrage become relatively strong. For further information, see the Box.

[9] If the sum of the costs of funding euros in the unsecured market and β (i.e., the FX swap-implied U.S. dollar rate from the euro) is less than the return from investing dollars obtained through an FX swap in a dollar risk-free asset, then it is possible for financial institutions that take a dollar buy/sell position in FX swaps to arbitrage. Hence, the non-arbitrage condition for investors who take a dollar buy/sell position in the FX swap market is the following:

$$\beta \geq USD\ OIS - EUR\ LIBOR.$$

Combining this condition with the one for investors who take a U.S. dollar sell/buy position shown in this context leads us into the non-arbitrage condition regarding β shown in the Box.

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