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European banks' funding realignment during the European debt crisis: impact of counterparty risk and funding liquidity on FX swap pricing

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Abstract

This study examines European banks' dollar procurement from U.S. money market funds (MMFs) through a sampled period (2010–2013) of the European debt crisis. It investigates whether banks in specific countries exerted stronger influence on foreign exchange swap pricing during distinct periods of the crisis, taking into consideration not only counterparty risk but also low funding liquidity. The factors contributing to the deviations in covered interest parity in foreign exchange swaps are also analyzed during four stages of the crisis. The empirical studies conducted indicate that counterparty risk of French banks raised the European premium at the peak of the crisis and during the period following outright monetary transactions. On the other hand, counterparty risk of German banks increased the European premium early in the crisis and after long-term refinancing operations (LTRO). The rise in premium became distinctly associated with funding stress due to banks' dependency on MMFs. LTRO generally alleviated stress for major European banks, but it did not compensate for counterparty risk at individual banks. The findings suggest that excess reserves held by banks in the euro area did not assure ample funding liquidity or offset counterparty risk. This excess reserve was amassed to hoard liquidity; however, liquidity available for funding diminished and served to widen the European premium.

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1. Introduction

Prime money market funds (MMFs) domiciled in the United States are key sources of short-term dollar financing for European banks. As fears about sovereign debt problems escalated with the European debt crisis around 2011, European banks suffered significant outflows of ready dollar sources in the form of MMFs. Consequently, these banks turned to foreign exchange (FX) swaps to secure dollars.

Numerous studies on the European debt crisis investigate spillovers from money market turmoil onto FX swaps and determine possible factors that heightened costs of raising dollars. Correa et al. (2012) relate European banks' liquidity shocks to broad concerns about sovereign risk without regard to any particular bank or country. Analyzing the 2007–2008 market turbulence, Baba and Packer (2008) conclude that a proxy capturing risk for an array of European banks supports a credit risk hypothesis.

This study, however, examines European banks' dollar procurement from MMFs through four identified periods during the crisis. It investigates whether banks in specific countries exerted stronger influence on FX swap pricing during distinct periods of the crisis. It also considers whether low funding liquidity, not just credit risk, affected swap pricing.

This paper is organized as follows: Section 2 shows the trend in European banks' dollar funding via MMFs and FX swaps for the period of December 2010 through December 2013. Section 3 hypothesizes that two factors drove deviations in covered interest parity (CIP). Section 4 provides the framework and results of the empirical analysis. Section 5 presents a conclusion.

2. European Banks' Funding Realignment

U.S. MMFs that had been major buyers of short-term debt issued by European banks drastically cut their European exposure in the second half of 2011—a situation that has been dubbed "a quiet run" (Figure 1). As U.S. branches of European banks lost access to dollar funding, their parent institutions had to tap their deposit base or access interbank markets to raise euros, which they used to acquire dollars via FX swaps. FX swaps are "secured" transactions in that they acquire dollars by posting domestic currency as collateral (euros in this case).

An FX swap for which EUR is the domestic currency is equivalent to the following stream of cash flows: (a) borrow EUR, exchange it for USD at the spot rate (S_t), and invest at $\left(r_{t,t+s}^{USD}\right)$; (b) on maturity, receive proceeds ($1+r_{t,t+s}^{USD}$); (c) convert proceeds from USD back into EUR at the forward rate ($F_{t,t+s}$); and (d) repay the loan $\left(1 + r_{t,t+s}^{EUR}\right)$.

CIP assumes that the FX forward discount rate should perfectly reflect the interest rate gap between two currencies. Therefore, equality between dollar rates and FX swap-implied dollar rates from the euro defines a condition of indifference shown by

$$1 + r_{t,t+s}^{USD} = \left(1 + r_{t,t+s}^{EUR}\right)^{*} \frac{F_{t,t+s}}{S_t}. \quad (1)$$

USD funding through FX swaps is a combination of raising the domestic currency and an FX swap contract. Thus, the FX swap-implied dollar rate from the euro can be expressed as follows:

FX swap-implied dollar rate from the euro=EUR funding rate + FX swap cost (β) (2)

Under normal conditions, FX swap cost (β) converges into the interest rate differential between the unsecured dollar and euro markets. However, it is widely known that (β) deviates from its theoretical value (β^*) during periods of uncertainty. Although these

deviations are termed "basis cost" (Goldberg et al. 2011), this paper calls the deviations the "European premium"[1]or (α)—the extra cost of funding incurred by European banks.

$$\beta^* = USD\ funding\ rate - EUR\ risk\ free\ rate, \quad (3)$$

$$\beta = \beta^* + \alpha$$
$$= USD\ funding\ rate - EUR\ risk\ free\ rate + \alpha, \quad (4)$$

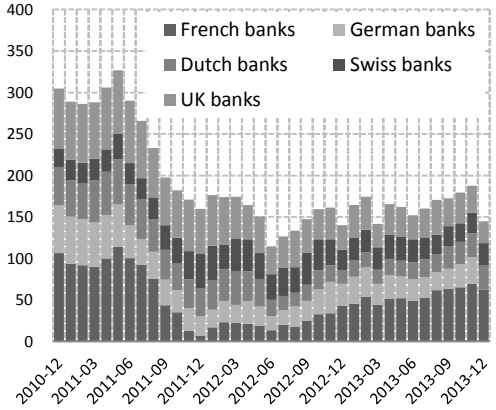
Considering the above discussion, equation (2) can also be expressed as follows:

FX swap-implied USD rate from the euro

$$= EUR\ funding\ rate + USD\ funding\ rate - EUR\ risk\ free\ rate + \alpha$$
$$= USD\ risk\ free\ rate + (USD\ funding\ rate - USD\ risk\ free\ rate)$$
$$+(EUR\ funding\ rate - EUR\ risk\ free\ rate) + \alpha \quad (5)$$

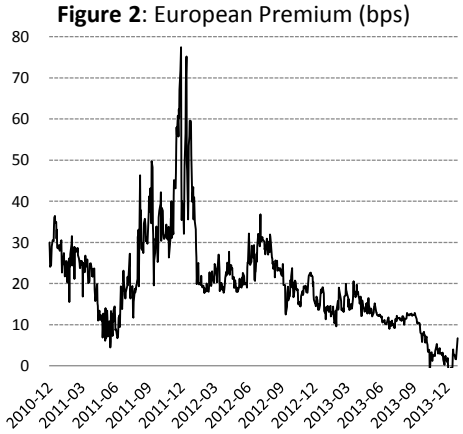
Figure 2 reveals its sharp upswing of the premium during December 2010–2013, which coincided with a sharp curtailment in the exposure of MMFs to European banks. This correspondence implies that the funding realignment from unsecured to secured loans (FX swaps) was sufficient to cause a substantial deviation.

Figure 1: U.S. MMF exposure to EU bank



Source: Fitch Ratings

Figure 2: European Premium (bps)



Source: Data Stream, Tullet Prebon

3. Decomposing of European premium and hypotheses

3.1 Two main hypotheses

The study's empirical analysis tests two hypotheses. First, perceived differences in counterparty risks by European and U.S. banks may explain the European premium. If the FX swap-implied dollar rate is higher than the actual market rate, the difference (i.e., a positive basis spread or "European Premium") may reflect the fact that interest rates could be prohibitively high for European banks in the dollar market, suggesting an unfavorable forward exchange rate for those banks.

The second hypothesis concerns the availability of euros, which European banks have easier access to than dollars. The study assumes that if the FX swap-implied dollar rate $(r_{t,t+s}^{USD})$ in equation (1) is higher than the actual market rate(r_{mkt}^{USD}), the difference may reflect not enough euro liquidity in the banking system, which implies a higher euro rate$(r_{t,t+s}^{EUR})$.

This study's two-step approach first assesses the impact of credit and liquidity risk of

[1] It is similar to the Japan premium in the late 1990s, when creditworthiness of Japanese banks had deteriorated. Faced with extreme difficulty raising dollars in interbank markets, Japanese banks turned to FX swaps, causing substantial deviations from CIP (Hanajiri 1999).

French and German banks on the European premium. The study examines French and German banks because they were the dominant dollar borrowers from MMFs during the sampled period. Step two determines whether credit risk for banks in Greece, Italy, Portugal, and Spain (GIPS)[2] affected the European premium.

3.2 Sampled periods

The study sample covers four periods of the crisis:
(1) Early stages (December 1, 2010 to May 31, 2011)

(2) Crisis peak (June 1, 2011, when Moody's Investors Service downgraded Greek debt three rungs, to December 21, 2011)

(3) Post long-term refinancing operations (LTRO), (December 22, 2011, settlement date of the first LTRO, to July 25, 2012)

(4) Post outright monetary transactions (OMT) (July 26, 2012, when European Central Bank (ECB) President Mario Draghi proclaimed[3] the ECB would do "whatever it takes" within limits of its mandate to preserve the euro, to December 31, 2012)

3.3 Variables

The European premium: The difference between the FX swap-implied three-month dollar interest rate from the euro and three-month dollar LIBOR[4] is the dependent variable in all the regression analyses that follow.

Relative default risk: The expected sign of the correlation of counterparty (credit) risk with the basis depends on whether the credit risk is greater for U.S. banks or for European banks. If the credit risk increases more for European banks, then their USD funding rate increases more than $\text{LIBOR}^{\text{USD}}$, so the basis increases; in the reverse case, the basis decreases. Using a framework (based on Coffey et al. (2009), Baba & Packer (2009)), banks are grouped as U.S.,[5] French,[6] or German[7] and simple averages of five-year CDS spreads are used for each. Apart from British banks that can execute sterling/dollar FX swaps, French and German banks are the top dollar borrowers from U.S. MMFs. CDS spreads for U.S. banks are subtracted from those for French and German banks to highlight differences in counterparty risk.

LIBOR-OIS[8] difference between the euro and U.S. dollar: The variable is the difference between two calculations. First, U.S. dollar OIS was subtracted from U.S. dollar LIBOR to observe stress in the unsecured dollar market. Second, euro OIS was subtracted from euro LIBOR or Euribor[9] to observe stress in the unsecured euro market. This variable is labeled $LIBOR\text{-}OIS^{USD-EUR}$. OIS rates tended to move below corresponding currency LIBOR with almost constant small margins. However, LIBOR-OIS spreads widened substantially, particularly for the dollar and the euro, after the onset of the financial crisis in August 2007 (IMF 2008a). One commonly cited factor was deterioration in funding liquidity for banks. If banks find it more difficult to service or roll-over their short-term liabilities as

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[2] I omit Ireland because Eurozone banks' claims on it have been small.

[3] https://www.ecb.europa.eu/press/key/date/2012/html/sp120726.en.html

[4] Dollar LIBOR (London Interbank Offered Rate) is an indicative average interest rate at which 18 major global banks are prepared to lend one another unsecured funds

[5] Bank of America, Citi, JPMorgan Chase.

[6] BNP Paribas, Societe Generale, Credit Agricole.

[7] Deutsche Bank, West LB, Commerzbank.

[8] The overnight index swap (OIS) rate is the rate on a derivative contract for the overnight rate. It measures market expectations for overnight funds rate during the term of the contract.

[9] Euribor (Euro Interbank Offered Rate) is the indicative average interest rate at which 25 panel banks with the highest turnover in euro money markets will lend one another unsecured funds.

they fell due in the unsecured dollar market than in the unsecured euro market, this spread should widen (IMF 2008b). Although LIBOR-OIS spreads may capture some counterparty risk (Gorton and Metric 2012), Schwarz (2014) and Michaud and Upper (2008) suggest that liquidity factors were more important. The liquidity risk hypothesis expects them to correlate significantly and positively during a crisis.

US MMF exposure to French and German banks: French banks' dollar borrowings from US MMFs fell sharply toward the end of 2011 (Figure 4). Unless banks reduced dollar assets at a similar pace, they needed to aggressively acquire dollars via FX swaps. German banks' MMF dollar intake at the time exceeded that of French banks. If the liquidity hypothesis is correct, correlations should be negative and significant.

Excess reserves: During LTRO 1 and 2, ECB lent €1,019 billion to banks, most of which ended up in current accounts at the central bank (ECB 2014). Figure 3 presents the trend in monthly average of outstanding LTRO and excess reserves. The correlation coefficient for the two datasets is 0.96. The analysis uses those reserves as a proxy for availability of euros in the banking system to test the second hypothesis. They should correlate negatively and significantly throughout the period.

VIX: In order to control for general market risk, an equity market's implied volatility is used to measure the risk aversion of investors in the broad financial markets. The VIX is a key measure of market expectations of near-term volatility conveyed by S&P 500 stock index option prices. It may be informative with regard to variations in the premium to the extent that equity investors respond to the same set of risk factors as investors in the money markets.

Relative CDS spreads for GIPS banks: This variable denotes the simple average of five-year CDS spreads for the top banks in Greece,[10] Italy,[11] Portugal,[12] and Spain.[13] Following da Silva et al. (2013), the analysis also uses the iTraxx Europe Senior Financials 5Y TR, which is a basket of CDS contracts having 25 European banks as references. The iTraxx CDS was subtracted from CDS for the GIPS banks to assess the relative credit risk. The counterparty risk hypothesis presumes a positive and significant correlation.

Figure 3: LTRO outstanding and excess reserves (bln EUR)

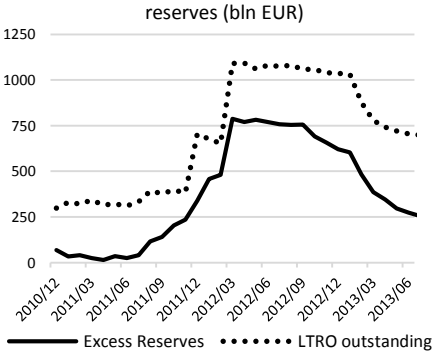
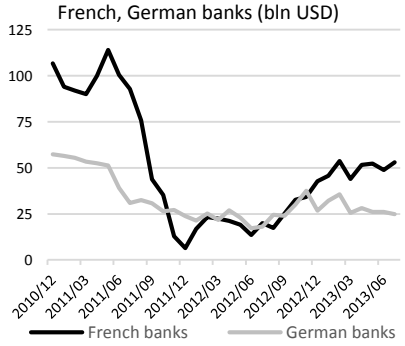


Figure 4: U.S. MMF exposure to French, German banks (bln USD)



4. Empirical Analysis

4.1 Method

OLS regressions for the four periods test whether differences in counterparty risk and market liquidity affected the European premium. As measured by three-month EUR/USD swap spreads, the OLS regression for the premium takes the form

[10] National Bank of Greece SA, Alpha Bank AE, EFG Eurobank Ergas SA.
[11] Unicredit Bank AG, Intesa Sanpaolo SPA, Banca MDP Di Siena SPA.
[12] Banco BPI SA, Banco Espirito Santo SA.
[13] Banco Santander SA, Banco Sabadell SA, Caixa Bank.

$$European\ Premium_t = \alpha + \beta_1 CDS\{US - (Fench\ or\ German)\}_t + \beta_2\{(LIBOR^{USD} - OIS^{USD}) - (Euribor - OIS^{EUR})\}_t + \beta^3(Excess\ Reserve)_t + \beta^4 MMF(French\ or\ German)_t + \beta^5(VIX)_t + \varepsilon_t. \quad (6)$$

A second OLS regression clarifies which GIPS country influenced the premium during each period.

$$European\ Premium_t = \alpha + \beta_1 CDS(EU - Italy)_t + \beta_2 CDS(EU - Spain)_t + \beta_3 CDS(EU - Portugal)_t + \beta_4 CDS(EU - Greece)_t + \varepsilon_t. \quad (7)$$

All data are from Datastream, except for excess reserves, which are from the ECB. MMFs' exposure to European banks is calculated using data compiled by Fitch Ratings.

4.2 Estimation Results

Results from the OLS regression of equation (6) appear in Table 1. The counterparty risk hypothesis appears to hold true as coefficients for CDS are significant and positive. It should also be noted that in three out of the four periods, risk aversion of investors in the broad financial markets, as measured by the VIX, appears to have played a role in variations of the European premium. The liquidity risk hypothesis also holds since LIBOR-OIS spreads are significant and positive for most periods and MMFs are significant and positive in the latter half of the observed period. Closer examination reveals that each variable takes a unique path.

The French-U.S. CDS spreads capture the difference in risk premium between French and U.S. banks. It is significant and positive at the peak of the crisis as well as during the post-OMT period when French banks' MMF turns significantly negative. This finding implies that FX swap market participants may have got nervous about French banks' situation as MMFs curtailed lending extended to them. French banks' funding difficulties via MMFs during this period could be one of the factors that affected the European premium.

The coefficient for the relative German-U.S. CDS spreads is significant and positive in the early stage and during the post-LTRO and the post OMT periods. During the post LTRO period, German banks' MMF activity was negative and significant to some extent, which indicates that German banks' funding strains caused by MMFs' withdrawal could have added to the widening of the European premium.

The coefficient of $LIBOR - OIS^{USD-EUR}$ is significant and positive during most periods. The results can be also assumed by replacing the funding rate and the risk-free rate in equation (5) with LIBOR and OIS, respectively, for the USD and EUR.

The coefficient turns non-significant during the post-LTRO period. LTRO likely alleviated European banks' funding stress in the money market. However, the significant and positive coefficient for German-U.S. CDS during the period suggests that any widening premium did not necessarily compensate for counterparty risk at individual banks.

The coefficient for excess reserves is significant and negative during the post-OMT period, suggesting the European premium widened when the banking system held less liquidity. This finding demonstrates the influence of liquidity on FX swap pricing. For the other periods, however, coefficients are significant and positive, contradicting the liquidity risk hypothesis. One explanation could be liquidity hoarding by banks anticipating losses (Berrospide 2013). If precautionary motives induced banks to boost their reserves at the ECB, they were available neither for immediate use nor to compensate for counterparty risk. In that situation "funding liquidity," defined by Brunnermeier and Pedersen (2009) as the ease with which investors and arbitrageurs obtain funding, should be low. The significant and positive

coefficients suggest that excess reserves did not necessarily assure funding liquidity and may even signal that a lack of it widened the European premium. However, hoarding may have receded after OMT alleviated solvency risk of GIPS banks.

Table 1: EUR/USD CIP deviation at 3 month maturity, OLS estimates

Variable		Early Crisis Stage	Peak of Crisis	Post LTRO	Post OMT decision
	from	2010/12/1	2011/6/1	2011/12/22	2012/7/26
	to	2011/5/31	2011/12/21	2012/7/25	2012/12/31
CDS French-US		-1.082	0.224*	-0.671	0.601***
		(-3.529)	(1.694)	(-4.742)	(4.731)
CDS German-US		0.891***	-0.116	0.423***	0.245*
		(5.236)	(-0.149)	(5.235)	(2.304)
LIBOR-OIS$^{USD-EUR}$		0.631***	0.738***	-0.202	0.078***
		(6.961)	(6.101)	(-0.281)	(3.008)
French bank MMF		-17.798	-0.222	-0.049	-0.536**
		(-1.708)	(-1.068)	(-0.135)	(-5.094)
German bank MMF		-0.468	-1.259	-0.690*	0.387
		(-0.084)	(-0.939)	(-1.671)	(1.975)
Excess Reserve		0.164***	0.058***	0.164***	-0.419***
		(3.256)	(2.390)	(3.369)	(-4.363)
VIX		1.214***	0.013	1.118***	0.378**
		(4.714)	(0.069)	(6.481)	(2.311)
Adjusted R-squared (%)		50.92	72.00	28.19	59.22
Observations		130	146	155	113

Note: Numbers in parentheses are t-stat. ***.** and* represent sigfinicance at 1%, 5% and 10% levels, respectively.

EU and GIPS CDS gaps in Table 2 reflect the influence of differences in counterparty risk between GIPS banks and a wider sample of large EU banks on FX swap pricing. Even post-LTRO, share prices of Italian banks kept falling, and Portugal's 10-year bond reached historical high yields. Perceptions of high counterparty risk influenced the premium. However, GIPS banks (excluding Italian banks) did not regularly participate in FX swaps during the sampled period. Thus, their perceived counterparty risk likely influenced swap pricing only indirectly. That is, their widening CDS spreads also raised the spreads of core country banks with large exposures to them.

Table 2: EUR/USD CIP deviation at 3 month maturity, OLS estimates GIPS banks relative counterparty risk

Variable		Early Crisis Stage	Peak of Crisis	Post LTRO	Post OMT decision
	from	2010/12/1	2011/6/1	2011/12/22	2012/7/26
	to	2011/5/31	2011/12/21	2012/7/25	2012/12/31
CDS EU-Italy		0.069	0.555***	0.777***	1.265***
		(1.406)	(19.675)	(4.544)	(5.493)
CDS EU-Spain		0.859***	0.020	-0.229	0.231
		(4.550)	(0.135)	(-2.234)	(1.263)
CDS EU-Portugal		1.253***	2.377***	1.267***	0.610***
		(8.130)	(8.541)	(5.191)	(4.643)
CDS EU-Greece		-1.062	0.291*	-0.199	0.208
		(-6.604)	(1.918)	(-1.594)	(0.744)
Adjusted R-squared		0.130	0.751	0.168	0.619
Observations		130	146	155	113

Note: Numbers in parentheses are t-stat. ***.** and* represent sigfinicance at 1%, 5% and 10% levels, respectively.

5. Conclusion

This study investigated the realignment of European banks' short term U.S. dollar funding from U.S. MMFs to FX swaps during the segment of Europe's debt crisis spanning 2010–2013 and analyzed factors underlying deviations from the CIP in the FX swaps during four stages of the crisis. Empirical results show that the relative counterparty risk of French banks appears to have contributed to the European premium—defined as the extra cost of funding incurred by European banks—at the peak of the crisis and during the post-OMT period. The relative counterparty risk of German banks appear to have been a driver of the premium in the early crisis stage and the post-LTRO period.

Behind the nervousness about the counterparty risk is the liquidity concern accentuated by the risk aversion of investors in the broad financial markets.

Liquidity risks at major European banks underpinned the higher premium throughout most of the sampled period. After early 2012, the premium became more clearly associated with funding stress arising from banks' continued or renewed dependency on MMFs. LTRO generally alleviated overall stress for major European banks, but it did not compensate readily for counterparty risk at individual banks.

Results also show that excess reserves held by euro-area banks neither signaled ample funding liquidity nor offset counterparty risk. If banks amassed reserves to hoard liquidity, liquidity available for funding diminished and served to widen the European premium.

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