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Deviations From Covered Interest Rate Parity: Evaluating Drivers for Changes

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Abstract

This paper evaluates the deviation from covered interest rate parity (CIP) after the great financial crisis. As a new phenomenon, this deviation has been approached both theoretically (violating the no arbitrage condition) and empirically. Through an extensive literature review, this study maps the possible drivers of the deviation and their proxies. We apply the analysis on a set of countries that are not yet explored in the related literature so far, even though represent a significant part of the foreign exchange market. Regarding the results, a significant weight in the financial drivers is obtained. The result claims for a deeper analysis and opens the possibility to evaluate this phenomenon under a new perspective.

Keywords: interest rate parity, deviation, liquidity, risk

JEL Classification Codes: E6, F3, F4

1. Deviations from CIP and Global Financial Crisis

The foreign exchange (FX) market is a significant part of the financial markets. It allows one country's money exchange for another, defining the exchange rate between them. Derived from comparing exchange rates and interest rate differentials, the theoretical concept of covered interest rate parity (CIP) holds that when there are no arbitrage

opportunities among these financial instruments. Despite this theoretical assumption, and its use in open economy and monetary models, empirical research has shown that CIP does not necessarily hold in practice.

Before the Global Financial Crisis (GFC), CIP was observed for most advanced economies. Small deviations from it were arbitraged in the short run. However, after the GFC, large and persistent deviations were observed for the most liquid currencies in the FX market. This research empirically studies the deviation from CIP and the possible drivers for this phenomenon over a set of advanced market economies.

Some factors that can cause the deviation (``basis'') and the incapacity of being arbitraged away have been identified in the literature. They are usually explained by: transactions costs, counter-party credit risk, lack of liquidity in secondary markets, and lack of funding due to systemic withdrawal by short-term lenders in a currency. Different papers have tried to explain the deviations by using models and/or empirical analysis to explain and quantify it. Funding shortage and counterparty risk are present in most of the post-GFC literature as important factors.

Between 2001 and 2007, the world's economy experienced a period of stability and growth, followed by a global financial crisis and a period of dollar squeeze in 2008-2012. As the most liquid currency, several international banks increased their holdings of US dollar assets. This dollar funding was raised, primarily, through market operations: the bank raises domestic currency through deposits and lends them against US dollars. In normal times, it is done through the interbank market, operations with central banks, and FX swaps to convert domestic currency funding into dollars. With the financial crisis and the Lehman Brothers bankruptcy, lenders became risk averse, increasing the difficulty of keeping these operations active.

Several research papers present in their theoretical models and empirical analysis an important role for intermediaries. Despite the theoretical assumption of costless arbitrage, the actual no arbitrage condition requires a lot of resources, and regulatory requirements also raise the cost. Before the crisis, the collateral and margining

requirements for arbitraging interest rates and exchange rate differentials were much less prohibitive in balance sheet requirements.

Given the scenario of positive basis in some currencies, the understanding of possible causes is an interesting and current research question. I begin this paper with a selected and critical literature review of theoretical models, empirical analysis and stylized facts developed to explain currency basis. With this map, I am able to identify the literature gaps and establish my contributions. My main contribution is to analyze the post GFC period in a cross-country setup. Most of the work has been done for specific currencies like US dollar, Euro and Japanese Yen, and this broader approach aims to compare deeply the drivers for the deviation. Additionally, the channels in the literature have been evaluated in single fashion, i.e., added in some theoretical model alone. I have claimed to see how relevant the channels still remain when evaluated together.

Based on data from Bloomberg, the World Bank, and the Bank of International Settlement (BIS), I have tested how several variables might get potential explanations for the deviations in a different set of countries. The following sections start with the literature review - divided before and after the GFC (and this last period grouped by theoretical and empirical evidences). After that, I present the methodology and data, as well as justifications for the choices. Then the results are presented, and the paper concluded.

2. CIP analysis through time

The CIP literature can be divided in two periods: before and after the 2008 GFC. In the first period, CIP was empirically confirmed to hold in practice. This means that small deviations were arbitraged away in short durations. After the 2008 crisis, some papers identified substantial deviations, and these bases have been showing persistent behavior, raising questions about the CIP concept. A large literature tests the CIP condition before the global financial crisis and documents large CIP deviations during the crisis. This work focuses on the post 2008 period.

2.1. Theoretical Evidence

A considerable part of the literature, besides identifying the deviations on CIP, proposed models to explain them. Several mechanisms serve as motivation for the modeling exercise: currency as a scarce good, banking lending behavior, application to monetary policy and zero

lower bound, and corporate funding cost arbitrage (Bottazzi, Luque, Pascoa, & Sundaresan, 2012; Ivashina et al., 2015; Amador, Bianchi, Bocola, & Perri, 2017; Liao, 2016). Some models approached the problem by using a dynamic general-equilibrium model with margin constraints (Garleanu & Pedersen, 2011). The CIP deviation may also be some component of a model with a distinct primary goal, such as exchange rate determination (Gabaix & Maggiori, 2015). Below, I add more details of the theoretical development.

As the channels of liquidity during the crisis were scarcer, a model by Bottazzi, Luque, Pascoa, and Sundaresan (2012) proposed the cross-currency basis (which captures the deviations from CIP) as the relative value of the scarcer currency. This hypothesis was able to match the data, by checking collaterals as funding constraints. In a crisis, banks are more reluctant to lend a scarcer currency, and it is priced into the cross-currency basis.

Ivashina, Scharfstein and Stein (2015) approached the problem by the credit quality of the banks, which ultimately works as intermediaries for these operations. Using the financial friction as a way to sharpen the bank behavior, this channel also matches the data.

The zero-lower bound (ZLB) limitation faced in the crisis was also explored as a channel for explaining the deviation from CIP. The constraint on nominal interest rates works as a source of limitation to arbitrage (Amador et al., 2017). Liao (2016) examined the issue through the lens of corporate fund cost. To explain it, the author developed a model of market segmentation, in which post-crisis regulations and intermediary frictions hampered arbitrage.

Garleanu and Pedersen (2011) had a similar approach as Liao (2016), which was aimed for explaining deviations from LOOP. In their reasoning, a funding-liquidity crisis raises the price gaps between securities with identical cash-flows but different margins. Gabaix and Maggiori (2015) explored the topic in a model with moral hazard and imperfect financial markets.

The banking regulation evidence is developed in models of intermediary-based asset pricing (He & Krishnamurthy, 2012; Brunnermeier & Sannikov, 2014). Additionally, Gromb and Vayanos (2010) survey offers useful information on limits to arbitrage,

Brunnermeier and Pedersen (2009) on funding liquidity, Vayanos and Vila (2009) and Greenwood and Vayanos (2014) on preferred habitat.

2.2. Empirical Evidence

The literature on deviations from CIP also contains papers with a purely empirical approach, without focusing on developing new models. In this section, I present some of these papers and their methodology. This section will be important for discussing proxies, identification of the basis, and measurement analysis.

Baba, Packer and Nagano (2008) analyzed the deviation in money markets in the second half of 2007. They identified the use of swap markets to circumvent US dollar funding shortages and linked it with deviations from CIP. Their analysis contemplated a small window of 2007 and 2008.

Coffey, Hrung, and Sarkar (2009) explored the margin conditions and the cost of capital as drivers of CIP deviations, especially during the crisis period. With increasing uncertainty about counterparty risk and scarcer swap lines, a breakdown of arbitrage transactions in the international capital markets was evaluated.

Adding more emphasis in the post-crisis period, Du et al. (2017) identified the CIP deviations as a combination of cost of financial intermediation and international imbalances in investment demand and funding supply across the currencies. Costly financial intermediation can explain why the basis is not arbitraged away post crisis.

Rime, Schrimpf, and Syrstad (2016) also focused on the role of money market segmentation on CIP deviations. With funding liquidity differences, it becomes impossible for FX swap intermediaries to supply the markets without eliminating arbitrage conditions.

Sushko Borio, McCauley and McGuire (2016) linked the estimated dollar hedging demand (quantities) to the variation in CIP deviations (prices). The authors argue that the degree to which CIP holds depends more the relationship between the forward and spot price than the interest rate differential, by showing that the CIP deviations rely mostly to hedge the USD forward. This is explained by the cost associated to this hedge over regulatory aspects: it causes some allocation on the balance sheet. With limits to arbitrage, CIP arbitrageurs charge a premium in the forward markets for taking the

other side of FX hedgers' demand in proportion to their balance sheet exposure. This will allow us to proxy the USD funding needs in FX swap markets by banks through the financial system net liabilities.

3. Methodology and Data

By mapping all the different approaches and proxies discussed in the literature, it is interesting to check how this proxy performs together and across a larger set of countries, instead of a particular one. Being able to identify the possible "top drivers" to the phenomena has immediate applications to policy makers, like monetary authorities. Potential candidates for drivers are justified theoretically from the economic and financial literature. The arguments above are explained in the following two bullets:

- Are the variables used as possible drivers in the literature extensible to the new set of countries?
- What are the commonalities and differences in the deviations from CIP among countries?

Some common explaining factors can be identified in the literature about deviation for CIP, regardless of whether they have a theoretical or empirical approach. According to the literature review, liquidity and counterparty risk play a big role in driving these deviations, but other factors might help explain it (demand for US dollars, risk from global banks, and financial variables).

Traditionally, these deviations were around zero in developed countries, and it seems reasonable that the recent literature focuses over the most relevant currencies in the FX market, like US dollar, Euro, and Japanese Yen. Nevertheless, according to the Bank of International Settlement (BIS), the Foreign Exchange Survey realized in 2019 (BIS, 2019), the group composed by Australian dollar (AUD), Canadian dollar (CAD), Swiss franc (CHF), Pound Sterling / British Pound (GBP), and Singapore dollar (SGD), respond for more than 5% of the daily turnover on the foreign exchange market (table 1 below). Given this relevance and the trend of participation, it is interesting to check how deviations from CIP behaved for this group.

It is a relevant research question to investigate how the deviations from CIP behaved for these currencies, and to investigate if the same factors found on the literature can be applied to this new set. In the scenario where similar evidence is found, it is possible to extend

the reach of the models that absorb these stylized facts to a wider range of countries. If the empirical behavior for this new set of currencies shows a different outcome, then a natural consequence of the research would be to explore other possible factors that might explain such behavior, and how the existing models can be extended to absorb such behavior in that group.

3.1. The Variables[2]

In this section, I will present, discuss, and justify the variables selected for my analysis. The research question of this paper is to evaluate the possible drivers for deviation for CIP for the selected countries. The first step is to measure the basis over these currencies. For this, I will use the approach of Du et al. (2017) on considering the basis as the spread between cross-currency swap and USD Libor.

3.1.1 Basis and Cross-Currency Swaps

Following Nakisa (2011), we establish an example to understand the banking role in the FX swap market.

> *"Let's take the scenario of European banks with liabilities in dollars. As the euro falls against the dollar, the cost of these payments increases. The situation is worsened by US investor's fear to lend to any European firms and banks. Through a cross-currency swap, banks can raise funding in Europe in euro and transform this into dollars at a fixed currency exchange rate that is agreed up front. The basis swap will allow the bank to transform their dollar liability into a euro liability they can fund more easily. The cross-currency basis swap will convert the lump sum that the bank borrowed in euros into a lump sum in dollars. The counterparty in the cross-currency basis swap will actually pay the bank a little less than the euro rate and pocket the difference between the euro rate and the rate on the swap. If banks are desperate for dollar funding, they will be willing to receive less interest on the euro interest on the swap. Cross-currency basis swaps are quoted as this difference in interest received. Turning this around, it is extremely cheap for US*

[2] Following the literature, I have also considered as proxies: volume of currency pairs (liquidity), demand for USD (risk), implied volatility and risk-reversal-25-Delta (financial). All these variables have a high correlation with the covariates used and haven't added explanation power to the results. For space limitation, I have maintained them out of the results showed, but they are available upon request.

banks to convert euro liabilities into dollars. Then, the cross-currency basis swap rate measures deviations from the CIP condition Libor interest rate swap rates." (Nakisa, 2011).

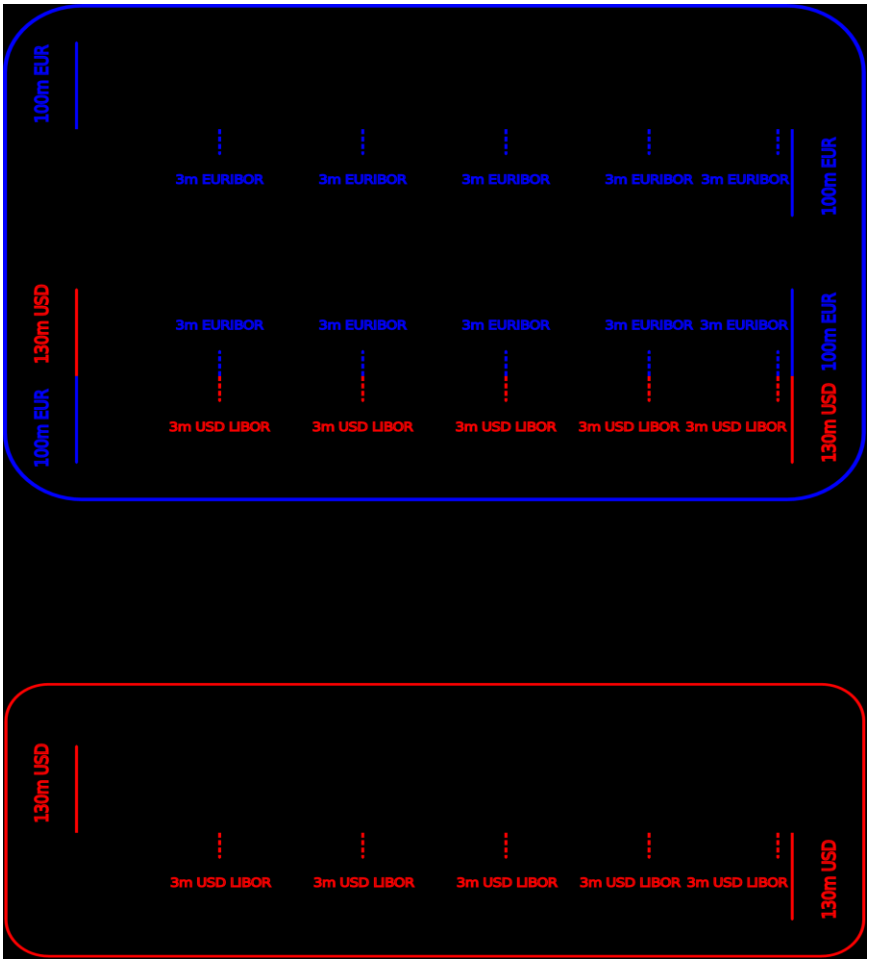

Figure 1: Cross Currency Swap and Deviation from CIP

Table 2: Basis Evaluation

Dollar Demand Vs Euro	Basis Swap Swap Rate	Swap EUR -> USD	Swap USD -> EUR
High	Decrease (more negative)	More expensive	Less expensive
Low	Increase (more positive)	Less expensive	More expensive

As the demand for dollar funding has increased, the euro dollar basis swap rate has fallen sharply and has become strongly negative. The data collected from Bloomberg for the currencies selected was compiled in the tables below for two maturities: one and five years. For comparison, the G10 currencies were also compiled, but presented in the appendix.

The literature review argued an increase on the deviations from CIP after the GFC, with some persistent behavior. Following Coffey et al. (2009) and Du et al. (2017), the period break proposed to analyze the deviation is composed by two intervals: the first part goes from January 1st, 2000 to September 15th, 2008, the official bankruptcy date of the Lehman Brothers. The second period goes from September 16th, 2008 until December 31st, 2018. The averages and standard deviation are presented on table 3 and illustrated on figures 2 and 3.

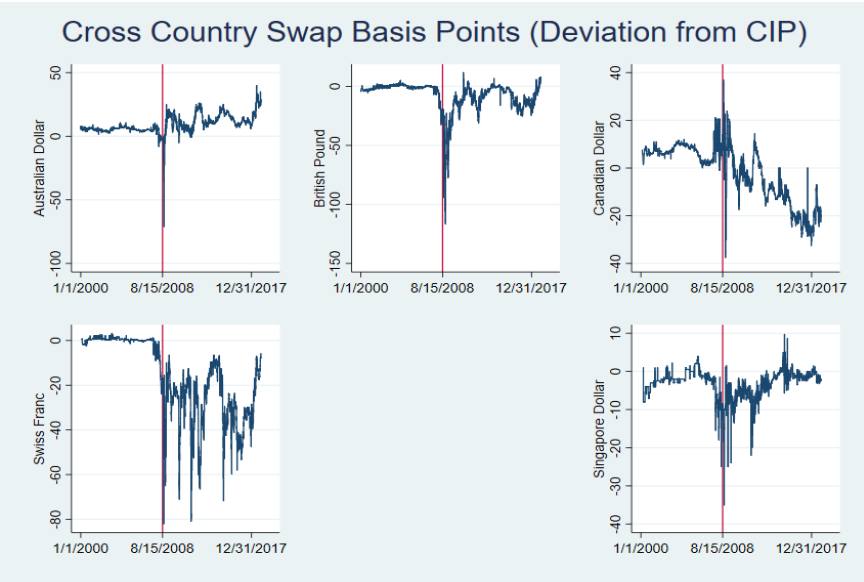

Figure 2: Cross Country Swap Basis Points (Deviation from CIP)

The additional variables presented in the literature review which will compose the regression analysis, are explained below:

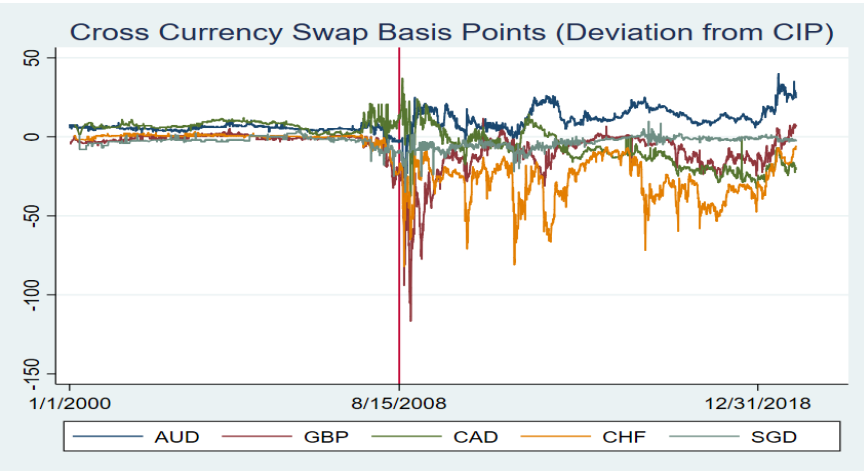

Figure 3: Cross Country Swap Basis Points (Deviation from CIP)

3.1.2. Liquidity proxies

- Spread Spot - difference between the prices quoted for an immediate sale (offer) and an immediate purchase (bid) for the spot exchange rate. The data was collected on Bloomberg.
- Spread Future - difference between the prices quoted for an immediate sale (offer) and an immediate purchase (bid) for future exchange-rate contracts. The data was collected on Bloomberg.

3.1.3. Risk proxy

- CDS G-Sibs - calculated by the author. Average of the 30 global systemically important banks CDS defined by the Financial Stability Board (see table 4).

Table 4 : G-SIBs Defined by Financial Stability Board

JP Morgan Chase	Bank of China	Industrial and Commercial Bank of China Limited
Bank of America	Barclays	Mitsubishi UFJ FG
Citigroup	BNP Paribas	Wells Fargo
Deutsche Bank	China Construction Bank	Agricultural Bank of China
HSBC	Goldman Sachs	Bank of New York Mellon
Nordea	Standard Chartered	Credit Suisse
Royal Bank of Canada	State Street	Groupe Crédit Agricole
Royal Bank of Scotland	Sumitomo Mitsui FG	ING Bank
Santander	UBS	Mizuho FG
Société Générale	Morgan Stanley	

Source: Financial Stability Board

3.1.4. Financial Market and Macro Variables

- Terms of Trade - Prices of the exports of a country relative to the prices of its imports. Obtained on Bloomberg.
- Bank Concentration - Calculated by the World Bank. It measures the weight of the five largest banks in the country (by assets).
- VIX - Measure of the stock market's expectation of volatility implied by S\&P 500 index options, calculated and published by the Chicago Board Options Exchange (CBOE). Obtained on Bloomberg.

4. Results

4.1. Regressions

Tables 5-9 compile the regressions for all currencies having the basis as the dependent variable and the statistical significance of each independent variable is described in sections 3.1.2 - 3.1.4, added accordingly to its economic meaning and relation to the literature.

Additionally, I added a dummy for post crisis period (September 15th, 2008, the Lehman Bank bankruptcy). This dummy represents a fixed effect for pre and post period, allowing me to control for unobservable differences in CIP before and after crisis. There was a concern regarding the scenario where CIP was just at a different level after the crisis for reasons not captured by the regressors, indicating the necessity of time fixed effect control for it. As the data has daily frequency not only on the dependent variable, but also in the regressors, this was ruled out.

As I am looking for the potential changes in the relationship between the explanatory variables and CIP during the crisis, then I will look for the interaction among dummies and regressors for pre and post crisis periods. I will start with a baseline model (regression 1), which contemplates most used liquidity variables – spread for spot and future contracts and terms of trade. Additionally, I will evaluate an extended model, which will embrace also other variables used as possible drivers for deviation on CIP, like Bank concentration, average CDS premia for global systemically important banks, and global volatility index (regression 2). Both models were added on a lagged term for the dependent variable.

The regressions assume the form:

$$CCS_t = \beta_0 + \beta_1 * Spot_t + \beta_2 * Future_t + \beta_3 * TOT_t + \beta_4 * D * Spot_t + \beta_5 * D * Future_t + \beta_6 * D * TOT_t + \beta_7 * D + \beta_8 CCS_{t-1} \quad (1)$$

$$CCS_t = \beta_0 + \beta_1 * Spot_t + \beta_2 * Future_t + \beta_3 * TOT_t + \beta_4 * D * Spot_t + \beta_5 * D * Future_t + \beta_6 * D * TOT_t + \beta_7 * BC_t + \beta_8 * CDS_t + \beta_9 * VIX_t + \beta_{\{10)} * D * BC_t + \beta_{11} * D * CDS_t + \beta_{12} * D * VIX_t + \beta_{13} * D + \beta_{14} CCS_{t-1} \quad (2)$$

where:

CCS – Cross-currency swap basis points

Spot – Spread spot (section 3.1.2)

Future – Spread future (section 3.1.2)

TOT – Terms of trade (section 3.1.4)

D– dummy for the period related to the Lehman Brothers bankruptcy (D = 0 before the event, and D = 1 after the event).

BC – Bank concentration (section 3.1.4)

CDS – Average of GSIBs CDS (section 3.1.3)

VIX – Volatility index (section 3.1.4)

CCS_{t-1} – lagged cross-currency swap basis points

For the five countries evaluated (tables 5-9), only UK and Singapore (tables 8 and 9) show significant result for the interactions on bank concentration, average CDS of G-Sibs and VIX. Nevertheless, the bank concentration coefficient shows opposite signs, weakening our interpretation. The results suggest the financial and macro variables as highly correlated with this new scenario of deviation from CIP. The cause for the Singapore result might be caused by its particular degree of freedom over its financial market, which caused less risk aversion over its currency. Regarding the spot and future spread, the results are mixed. Australian dollar, Canadian dollar and British Pound show no correlation, while the Swiss franc shows significance only in the future spread, and Singaporean dollar shows significance in both spot and future.

The high significance on terms of trade (Australian dollar and Canadian dollar) can be an indication of the real export channel getting higher weight through this period. The significance of the Volatility Index is consistent with Avdjiev, Koch and Shin (2016)'s work as a

control variable to identify the impact of the financial channel over the exchange rate.

The lack of significance of the bid-ask spread for spot and/or future markets for some currencies is intriguing. The increase of CIP post GFC has as one of main hypothesis the liquidity constraint. Also, one of the most practiced proxies for liquidity concerns the bid-ask spread. Nevertheless, we see that the significance over the interaction with the post-Lehman dummy is present over independent variables with institutional characteristics, like terms of trade and bank concentration, and global factors, like Vix and the CDS premium of G-Sibs (UK and Singapore). This fact raises questions about the proper intervention policies from the regulators.

For example, one of the first responses from the FED to the crisis was the incentive of some mergers in order to absorb the more problematic banks. It is noteworthy that the main idea was to "stop the bleeding" and avoid bank-runs through all the system, but this result tries to shed light about the cost of a higher bank concentration as a narrower set of institutions to channel the liquidity to the real economy.

Regarding the VIX and the G-Sibs CDS (British Pound and Singaporean dollar), the main lesson provided by this result was well explored: the lack of regulation and criteria from regulatory agencies that are supposed to supervise the financial institutions, contributed to the increase on leverage and risk profile for all the major banks.

I have approached the analysis with linear regressions. The possible limitations of heteroskedasticity were contemplated by robustness on the errors. Despite the fact that these variables could be evaluated as time series, these are mostly financial instruments and concepts constructions (like bid-ask spread, and terms of trade), or institutional statistic (bank concentration). To enhance the results interpretation, I have added a lagged term for the cross-currency basis. The high frequency of the data adds much noise to the evaluation. Even considering it, it's safe to assume that the simple model proposed captures significant part of the variance – with R-squared close to 1 for the countries sample).

Table 5: Australian Dollar Cross-Currency Swaps Regressions

	(1)	(2)
VARIABLES	**AUD_CCS**	**AUD_CCS**
Spot spread	-0.516	-0.636
	(1.182)	(1.420)
Future spread	-0.00500	-0.00161
	(0.00626)	(0.00678)
Terms of trade	-0.00171	0.000953
	(0.00133)	(0.00219)
D * (Spot spread)	9.203	9.323
	(6.109)	(6.236)
D * (Future spread)	0.383*	0.252
	(0.233)	(0.276)
D * (Terms of trade)	-0.00560*	-0.00717*
	(0.00300)	(0.00417)
Bank Concentration		0.00495
		(0.00494)
Average CDS G-Sibs		-0.00407
		(0.00310)
VIX		0.00606
		(0.00603)
D * (Bank Concentration)		0.0673
		(0.0558)
D * (Average CDS G-Sibs)		0.00569
		(0.00365)
D * (VIX)		-0.00886
		(0.0144)
Lag – CCS	0.968***	0.955***
	(0.0238)	(0.0304)
D	0.402	-5.830
	(0.258)	(5.160)
Constant	0.175	-0.242
	(0.131)	(0.389)
Observations	4,757	4,335
R-squared	0.963	0.962

Note: Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1)
The dummy variable is defined by the Lehman Brothers bankruptcy, so it assumes value 0 for the period defined in Jan 1st,2000 – Sep 15th, 2008, and value 1 for the period defined in Sep 16th, 2008 – Dec 31st, 2018. All independent variables are described in section 3.1.

Table 6 : Canadian Dollar Cross-Currency Swaps Regressions

	(1)	(2)
VARIABLES	**CAD_CCS**	**CAD_CCS**
Spot spread	92.72	33.04
	(146.5)	(156.9)
Future spread	-0.000600***	-0.000420***
	(0.000155)	(0.000159)
Terms of trade	0.00165	-0.0122
	(0.00910)	(0.0121)
D * (Spot spread)	-19.13	-36.78
	(181.4)	(214.1)
D * (Future spread)	-0.00425	-0.000337
	(0.0202)	(0.0187)
D * (Terms of trade)	0.0291**	0.0586***
	(0.0135)	(0.0200)
Bank Concentration		0.0249***
		(0.00916)
Average CDS G-Sibs		0.00169
		(0.00406)
VIX		0.00445
		(0.00986)
D * (Bank Concentration)		0.00346
		(0.0121)
D * (Average CDS G-Sibs)		0.00244
		(0.00424)
D * (VIX)		0.00543
		(0.0156)
Lag – CCS	0.978***	0.955***
	(0.00559)	(0.0102)
D	-0.554***	-1.817*
	(0.174)	(1.010)
Constant	0.128	-1.955***
	(0.0838)	(0.744)
Observations	4,570	4,298
R-squared	0.982	0.981

Note: Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1)
The dummy variable is defined by the Lehman Brothers bankruptcy, so it assumes value 0 for the period defined in Jan 1st,2000 – Sep 15th, 2008, and value 1 for the period defined in Sep 16th, 2008 – Dec 31st, 2018. All independent variables are described in section 3.1.

Table 7: Swiss Franc Cross-Currency Swaps Regressions

	(1)	(2)
VARIABLES	**CHF_CCS**	**CHF_CCS**
Spot spread	-18.39	50.98
	(79.45)	(97.75)
Future spread	-0.00222	-0.00233**
	(0.00151)	(0.000940)
Terms of trade	0.0193***	0.0263***
	(0.00733)	(0.00920)
D * (Spot spread)	114.1	67.36
	(99.20)	(120.3)
D * (Future spread)	-2.134**	-3.254***
	(0.866)	(0.907)
D * (Terms of trade)	-0.0120	0.0594
	(0.0450)	(0.0847)
Bank Concentration		0.0235
		(0.0195)
Average CDS G-Sibs		-0.00291
		(0.00205)
VIX		0.000695
		(0.00543)
D * (Bank Concentration)		0.0518
		(0.0356)
D * (Average CDS G-Sibs)		0.000355
		(0.00247)
D * (VIX)		-0.0228
		(0.0169)
Lag – CCS	0.983***	0.972***
	(0.00662)	(0.00753)
D	-0.693	-4.376
	(0.472)	(2.706)
Constant	0.0836**	-2.008
	(0.0405)	(1.830)
Observations	4,470	4,193
R-squared	0.988	0.988

Table 8: British Pound Cross-Currency Swaps Regressions

	(1)	(2)
VARIABLES	**GBP_CCS**	**GBP_CCS**
Spot spread	-5.415	-5.805
	(4.411)	(4.382)
Future spread	-0.233	-0.226
	(0.146)	(0.141)
Terms of trade	-0.0239	-0.0392**
	(0.0146)	(0.0177)
D * (Spot spread)	27.90*	26.73*
	(14.38)	(14.31)
D * (Future spread)	0.247	0.244
	(0.155)	(0.150)
D * (Terms of trade)	0.130**	-0.0283
	(0.0560)	(0.0895)
Bank Concentration		0.000711
		(0.00211)
Average CDS G-Sibs		-0.00735**
		(0.00294)
VIX		0.00753
		(0.00662)
D * (Bank Concentration)		0.0574***
		(0.0216)
D * (Average CDS G-Sibs)		0.00632**
		(0.00315)
D * (VIX)		-0.0577***
		(0.0193)
Lag – CCS	0.985***	0.966***
	(0.00874)	(0.00971)
D	-1.033**	-3.201
	(0.438)	(1.950)
Constant	0.0595	0.121
	(0.0475)	(0.193)
Observations	4,495	4,197
R-squared	0.978	0.978

Note: Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1)
The dummy variable is defined by the Lehman Brothers bankruptcy, so it assumes value 0 for the period defined in Jan 1st,2000 – Sep 15th, 2008, and value 1 for the period defined in Sep 16th, 2008 – Dec 31st, 2018. All independent variables are described in section 3.1.

Table 9: Singaporean Dollar Cross-Currency Swaps Regressions

	(1)	(2)
VARIABLES	**SGD_CCS**	**SGD_CCS**
Spot spread	-261.5***	-363.9***
	(94.98)	(138.1)
Future spread	0.0285	0.0531**
	(0.0187)	(0.0232)
Terms of trade	0.0236**	0.0179
	(0.0100)	(0.0186)
D * (Spot spread)	267.7***	372.8***
	(95.65)	(138.8)
D * (Future spread)	-0.0288	-0.0537**
	(0.0187)	(0.0232)
D * (Terms of trade)	0.0159	0.0164
	(0.0122)	(0.0202)
Bank Concentration		0.0292
		(0.0390)
Average CDS G-Sibs		-0.0192***
		(0.00394)
VIX		-0.00330
		(0.00778)
D * (Bank Concentration)		-0.140***
		(0.0506)
D * (Average CDS G-Sibs)		0.0146***
		(0.00380)
D * (VIX)		-0.0184*
		(0.0103)
Lag – CCS	0.914***	0.807***
	(0.0193)	(0.0305)
D	0.0125	13.57***
	(0.0835)	(4.964)
Constant	-0.00146	-2.495
	(0.0615)	(3.933)
Observations	4,058	3,895
R-squared	0.875	0.883

Note: Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1)
The dummy variable is defined by the Lehman Brothers bankruptcy, so it assumes value 0 for the period defined in Jan 1st,2000 – Sep 15th, 2008, and value 1 for the period defined in Sep 16th, 2008 – Dec 31st, 2018. All independent variables are described in section 3.1.

4.1. Some Robustness Checks

A primary and simple check regarding the impact of the Lehman Brothers bankruptcy over the deviations from CIP was done through a t-test and mean comparison between the two periods. Despite an illustrative representation of the different behaviors through figures 2 and 3, a formal test is conducted, with its results available on table 10.

Table 10: T-tests for Mean Differences Pre x Post Lehman

	Difference	Std. Error	N (pre-Lehman)	N (postLehman)
Australian dollar	-7.5843***	0.1658	2231	2705
Canadian dollar	16.1801***	0.2615	2042	2704
Swiss Franc	27.6028***	0.3084	1960	2706
British pound	10.5057***	0.3336	2022	2703
Hong Kong dollar	16.0884***	0.2485	2206	2700
Singaporean dollar	1.2399***	0.1119	1635	2695

To improve the power of the results, I have also ran a panel analysis for the data to observe how that would differ from the cross countries results (without the lagged variables). They are available on table 11 and show similar results from the cross-country analysis.

Table 11: Cross-Currency Swaps Panel Regressions

	(1)	(2)
VARIABLES	**CCS**	**CCS**
Spot spread	-9.519	-15.13**
	(8.113)	(6.920)
Future spread	0.0371	0.0154
	(0.0528)	(0.0254)
Terms of trade	0.116***	0.186***
	(0.00559)	(0.00483)
D * (Spot spread)	-7.103	-28.63
	(27.32)	(23.55)
D * (Future spread)	-0.0290	5.90e-05
	(0.0540)	(0.0274)
D * (Terms of trade)	0.491***	0.465***
	(0.0107)	(0.0101)
Bank Concentration		0.0851***
		(0.00283)
Average CDS G-Sibs		-0.151***
		(0.00563)
VIX		0.328***
		(0.0116)

Table 11: Cross-Currency Swaps Panel Regressions

D * (Bank Concentration)		0.425***
		(0.0104)
D * (Average CDS G-Sibs)		0.140***
		(0.00629)
D * (VIX)		-0.487***
		(0.0230)
D	-11.64***	-41.26***
	(0.128)	(0.866)
Constant	1.980***	-7.783***
	(0.0514)	(0.305)
Observations	27,350	25,231
R-squared	0.311	0.398

Note: Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1)
The dummy variable is defined by the Lehman Brothers bankruptcy, so it assumes value 0 for the period defined in Jan 1st,2000 – Sep 15th, 2008, and value 1 for the period defined in Sep 16th, 2008 – Dec 31st, 2018. All independent variables are described in section 3.1.

As a frequent argument in the literature about the deviation from CIP resides on the lack of liquidity for the markets, I have checked how the Cross-country swap basis points behaved for the same six pairs of currencies for the period around the Quantitative Easing. I have run the same t-test for the means, but now comparing the QE1 and QE2 announcements dates, and also for a smaller window – two weeks before and two weeks after the announcement (tables 12 and 13).

Table 12: T-tests for Mean Differences Pre x Post QE1

	Difference	Std. Error.	N (pre-QE1)	N (post-QE1)
Australian dollar	-6.8956***	1.0737	15	17
Canadian dollar	21.8926***	6.1024	15	17
Swiss Franc	11.6559***	3.6944	15	17
British pound	0.6838	9.3846	15	17
Singaporean dollar	-6.6382***	1.2344	15	17

Table 13: T-tests for Mean Differences Pre x Post QE2

	Difference	Std. Error.	N (pre-QE2)	N (post-QE2)
Australian dollar	1.3836**	0.5211	22	23
Canadian dollar	-0.6337	0.6828	22	23
Swiss Franc	2.3772***	0.5815	22	23
British pound	0.224	0.2979	22	23
Singaporean dollar	0.3549	0.3927	22	23

The weaker results, with some currencies showing no difference in their means between the periods, are consistent with the idea that market liquidity is not the main driver for the deviation of CIP. The period of analysis for the change due to specific event (the QE announcements) was chosen to be small in an attempt to isolate its effect over the deviation from CIP. If extended to a larger period, the effect would probably be impacted from other market variables as well. Having that said, the regressions for these windows were not reproduced due to the small dataset and limited explanation power. This limitation raises a possibility for a future study with intraday data around the QE announcements.

5. Final Remarks

In this paper, I have empirically conducted an evaluation over the deviation from covered interest rate parity. Through an extensive literature review, I have mapped the possible drivers for explaining the failure of the no arbitrage condition in the foreign exchange market after the great financial crisis. I have also extended the analysis for a set of countries that are not explored in the literature despite having a significant weight in the FX market. I have obtained results that claim for a larger reason for the deviation than only liquidity constraints, which open channels for further empirical analysis as well as different channels for theoretical proposals on monetary policies models.

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