Inflation Differential as a Driver of Cross-currency Basis Swap Spreads

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Abstract

Over the last decade, the foreign exchange derivatives market has witnessed a collapse of covered interest parity (CIP). Not only does this collapse give rise to large deviations from CIP, it has unlocked a stream of exploitable arbitrage opportunities across currencies. In this paper, we introduce two new factors - inflation differential and relative economic performance - as potential drivers of deviations from CIP. Employing data on G10 cross-currency basis swap spreads viz a viz the U.S. dollar, we document a striking new evidence that higher inflation differential and incremental improvement in relative economic performance drive the basis wider, and hence arbitrage profits higher for U.S. dollar investors, in the post crisis period. Our main empirical results in general are robust to an extended number of controls, variations in sampling frequency, and consideration of alternative specifications, but the additional explanatory power is low.

Keywords: Cross-currency basis, inflation differential, relative economic performance

JEL Classifications: E1, F3, G1

1. Introduction

This article investigates the effects of inflation differential and relative economic performance on cross-currency basis, a measure of covered interest parity (CIP, henceforth) breakdown. The noticeable breakdown of the principle of CIP across many currencies is one of the most recent and well-known puzzles in the global fixed income and foreign exchange markets since the global financial crisis (GFC, henceforth) that emanated in the US in 2007/2008 and later spread to major developed capital markets and other parts of the world. In the international economics literature, the CIP is a no arbitrage condition that had been a major bedrock of other analytical models in standard open-economy macroeconomics – especially models that rely heavily on the no-arbitrage assumption – for several decades prior to the crisis. Given two currency pairs ($, €), CIP requires that borrowing in one currency ($), lending in the other currency (€) and hedging exchange rate risk with currency forwards, would yield a similar payoff in $. This condition broke down during the GFC; the deviations have since continued, which seems to suggest that agents can earn unlimited risk-free returns or benefit perpetually from lower funding cost.

As such, two major consequences have emerged from this breakdown. First, large multilateral development institutions can possibly lower overall $ funding costs by first borrowing in, say, € and swapping proceeds to $. With this outcome, these institutions can access $ funds at more favorable rates, which help to enhance their support for governments or private sectors in developing countries. Second, the deviations make hedging activities potentially riskless and more profitable for arbitraging asset-managers at reserve banks and other large financial institutions. For instance, reserve banks often swap some of their foreign currency reserves against other currencies, such as the Yen, to boost returns. Nonetheless, limits could exist for such arbitrage activities since some arbitraging agents – such as banks and the financial institutions that depend on them – are directly or indirectly constrained by regulations that place capacity limits on the amount of exposure they can absorb at a time on their balance sheets. This therefore makes the cost-benefit advantage of leverage unfavorable. As noted by Rime *et al*. (2019), the riskless returns from CIP deviations are almost insignificant for most arbitrageurs when reconciled with the actual dollar funding rates incurred. Even those that incur the least funding rates, and thus are in the best position to reap the most benefits from CIP deviation activities, are inhibited by stringent regulations.

Since surfacing in the wake of the GFC and subsequently, studies on CIP deviations have grown in the literature (Baba and Packer (2009), Du *et al*. (2018), Avdjiev *et al.* (2019)). A few studies have examined the emergence and implications of CIP deviations (Arai et al. (2016), Pozsar (2016), Courcel (2015, 2017), Nakaso (2017) and Ibhagui (2019)), and there seems to be some consensus in the literature that the turbulence which emerged in the GFC era led to dollar shortages that triggered CIP deviations. However, what remains largely unsettled are the prolonged existence, i.e. why the gap caused by CIP deviations has refused to close, and the drivers of the deviations, especially the various macroeconomic factors that are potentially linked to the evolution of CIP deviations. In some studies, such as Baba and Packer (2009), it has been suggested that the deviations are due to the existence of differences in counterparty risks. However, using both repo rates, to represent more secure borrowing and lending, and KfW bonds, Du *et al.* (2018) argue that CIP deviations are present even in the absence of counterparty risks. Thus, whether or not there are counterparty risks, it is clear that CIP deviations have remained. So, what factors drive these deviations?

A growing number of studies have begun to focus actively on the potential drivers of CIP deviations. More recently, there have been significant interests in the different drivers of CIP deviations, especially in the post-GFC era, and a few potential candidates have emerged (see Ivashina *et al*. (2015) Baran and Whitzany (2017), Avdjiev *et al.* (2019), Du *et al*. (2018), and Ibhagui (2018, 2019)). One variable that has recently dominated in the literature as a major potential driver of CIP deviations is the strength of the trade weighted broad dollar index. Using a host of market-related financial variables as controls, Avdjiev et al. (2019) provide robust evidence that a stronger US dollar goes together with larger CIP deviations and contractions of cross-border dollar bank lending. They argue for the existence of a triangular relationship where the US dollar plays the role of a barometer of risk-taking in the global capital markets. Their main result establishes that contraction of cross-border dollar lending, induced by dollar appreciation, which limits supply of hedging activities, drives CIP deviations wider (that is, the basis becomes more negative in absolute terms).

Other studies such as Ivashina *et al.* (2015), Du *et al*. (2018) and Rime *et al.* (2019) have argued for different limits to arbitrage which can potentially stifle the supply of dollar hedges, regardless of the level of demand for hedging activities, causing wider CIP deviations to persist. Du et al. (2018) argue for the existence of CIP deviations that cannot be explained by credit risks or transaction costs. They also show that bank balance sheet costs and asymmetric monetary policy shocks are important drivers of CIP deviations. Borio *et al*. (2018) document that net hedging demand needs explain the variations in CIP deviations observed across currencies. Looking at the corporate credit market, Liao (2016) examines corporate issuance patterns and links cost advantages, from the use of arbitrage in funding activities across currencies, with CIP deviations. Overall, the growing literature seems to suggest that factors which influence demand and supply of hedging activities should potentially impact the evolution of CIP deviations, at least in the short-run.

In another strand of the literature, several studies have noted that deviations from CIP can be explained by the relative funding liquidity risk premium of a currency vis-a'-vis the US dollars. A recent work along that line include Kohler and Muller (2019) who argue that relative funding liquidity risk affects not only the cash market but also the collateral markets as investors who exhibit a strong (weak) preference for US dollars (foreign currency) cash should also extend such preference to US dollar (foreign currency) denominated collateral. More importantly, they find that, among other measures, it is the cross-currency repo rates that best incorporate relative funding liquidity risk premium because the cash leg and the collateral leg are denominated in different currencies (for instance US dollar vs non-US dollar), which allows the collateral used to secure a transaction to be non-US dollar denominated. Using cross-currency repo rates to capture relative funding liquidity premium, they document that deviations from CIP are considerably smaller when calculated based on cross-currency repo rates instead of standard interest rates and that the remaining CIP deviations can be explained, in large parts, by the presence of different levels of positive and persistent relative funding liquidity risk premium arising due to the market's preference for holding US dollars as opposed to most other currencies.

In a related study, Wong and Zhang (2018) note that deviations from CIP are neither a mystery nor a financial market failure, but instead reflect a fair risk assessment or matching process that swap dealers undertake to adjusts prevailing interest rates in two different currencies to account for the differences that have developed in their risk characteristics over time and, in so doing, make a swap transaction fairer to parties involved. It is this adjustment - which aims to weigh each side by their degree of riskiness and ensure fairness to both sides of a swap transaction - that gives rise to deviations from CIP. According to them, Libor rates in two currencies are not equivalent as the currencies do not reflect equivalent risk levels, implying that the basis cannot be zero - otherwise a low risk counterparty would accept to ignore the riskiness of a high-risk counterparty and demand a premium or compensation for exposure to this high risk counterparty, a rationale which is clearly infeasible. They argue that the risk-adjustment process is necessary because, in general, funding liquidity and/or counterparty risk differ between domestic and foreign currency money markets, and the difference needs to be accounted for. Moreover, they also argue that the swap market functions as to separate counterparty risk and liquidity risk. They estimate that, on average, liquidity risk premium dominates counterparty risk premium for US dollars, while the reverse is true for the non-US dollar currencies, which is why swapping foreign currencies to US dollars (i.e. borrowing foreign currencies and lending US dollars) leads to the receipt of a greater discount from loans in foreign currencies, causing the bases to widen (more negative).

Other related earlier studies in this stream include Wong, Leung, and Ng (2016) and Hui, Genberg, and Chung (2011). Wong et al. (2016) argue that CIP holds much better when controlling for relative funding liquidity risk. Using a procedure which decomposes CIP deviations into counterparty credit and funding liquidity risk, they find that funding liquidity risk component plays a more dominant role in explaining CIP deviations. Meanwhile, in a 2-year event study of the GFC period, Hui et al. (2011) demonstrate that the observed CIP deviations could be explained by the existence and nature of liquidity constraints. They demonstrate that market-wide funding liquidity risk in the interbank market explain most of the deviations observed among major currency areas, especially in the pre-Lehman collapse. They show that counterparty credit risk also became important in the post-Lehman collapse as both counterparty risk and funding liquidity risk became significant determinants of CIP deviations in Europe. For Asia, they report much lower swap-implied US dollar interest rates in Hong Kong dollar, Singapore dollar, and Japanese Yen and attribute the relative discounts on these swap-implied rates to the relatively better dollar funding conditions (lower funding liquidity risk) in these Asian markets compared to Europe and even the US, which made these Asian markets an alternative source of dollar funding. Given the more benign dollar conditions Asia, their demand for dollars via the swap market was more limited, at least relative to European peers, lowering the swap-implied dollar costs in these currencies compared to European currencies for which swap-implied dollar costs became much more expensive because the extreme dollar funding strain in Europe implied higher dependence on the swap market as demand for dollars via the swap market elevates, pushing up the swap-implied dollar costs in these European currencies. The Federal Reserve Swap lines with central banks eased the liquidity pressure and lowered the swap-implied dollar costs in the European economies.

Our focus in this article is therefore to explore new potential drivers of CIP deviations. We contribute to the growing literature by providing robust evidence that inflation differential and relative economic outcomes have played a significant role in the evolution of CIP deviations post GFC. We find that, in general, when economic performance improves, or inflation differential rises in a country relative to the US, cross-currency basis swap spreads tend to widen, implying larger CIP deviations. Across maturities, inflation differential emerges as one of the most robust and significant drivers of the cross-currency basis. Thus, deviations from CIP respond to increases in inflation differential so that when there is a rise in inflation differential, CIP deviations tend to be larger. This negative co-movement between inflation differential and CIP deviations holds across the five-year and three-month maturities of the basis and is robust when we control for a host of other existing drivers of CIP deviations. The negative relation between relative economic performance and CIP deviations is robust and significant across a host of controls for the five-year maturity but loses its statistical significance for the three-month maturity when we control for other drivers of the basis, though the negative relation remains.

Our results also confirm previous findings, such as negative relations between dollar strength and CIP deviations (Avdjiev *et al.* (2019)). Our main results are robust to these previous findings. Furthermore, we examine the effect of inflation beta – representing the sensitivity of CIP deviations to inflation differentials – on the average level of cross-currency basis. This helps to determine whether disparities in the response of CIP deviations to inflation differential can explain incongruencies in arbitrage returns, or the magnitude of the cross-currency basis, across countries. In a cross-section framework, we show that currencies with higher exposure or sensitivity to inflation differential - that is those whose inflation betas increase to signal an increased sensitivity of CIP deviations to inflation differential - have larger CIP deviations and potentially higher arbitrage profits, where the arbitrage profits correspond to the magnitude of the average level of the cross-currency basis. This result provides some evidence that discrepancy in responses to inflation differential across currencies could potentially explain the dissimilarity in arbitrage profits associated with CIP deviations across countries.

Why do CIP deviations widen when inflation differential increases and relative confidence in the economy improves? Drawing from Chen (2010) and Avdjiev *et al*. (2019), we argue that possible answers to these questions follow from the links between economic performance and credit spreads, and between the dollar and cross-currency basis. First, a rise in inflation differential between country k and the US can induce depreciation of currency k, which can put an upward pressure on the dollar. As Avdjiev et al. (2019) note, higher dollar strength then leads to wider cross-currency basis. Thus, a rise in inflation differential leads to wider basis if currency depreciation, and hence dollar appreciation, accompanies increases in inflation differential and dominates in the transmission mechanism. Also, the result could operate via a dollar-asset demand channel. Under this mechanism, a rise in inflation differential induces an increase in demand for dollar-denominated fixed income assets hedged into some non-dollar benchmark rate as investors move to circumvent the ills of inflation on their positions. This demand for dollar-denominated fixed income assets increases the cost of synthetic dollars, which then widens the cross-currency basis and expands deviations from CIP. This channel takes the view that wider CIP deviations is a result of investors' desire to avoid the ills of rising inflation by holding dollar-denominated fixed income assets (hedged into local currency benchmark rate).

Second, and reasoning in line with Chen (2010), we note that, more often, when there are indications of better economic performance, credit spreads tend to tighten as improved economic confidence reduces uncertainty, increases business confidence and improves general perception of risk. The lower spreads thus induce higher issuance volumes in these currencies as lower spreads imply lower funding costs, consequently leading to higher hedging demand for dollar swaps and thus wider basis when higher demand for dollar hedges dominates in the transmission mechanism. In general, higher issuance in nondollar currencies can generate positive shocks to demand for hedging activity that leads to higher demand for dollar hedges and, through that, a wider cross-currency basis which worsens CIP deviations. Our paper also draws on Kohler and Muller (2019) to provide intuition of how lower borrowing costs in foreign currencies might elevate relative funding liquidity risk premium demanded by US dollar-based agents and thereafter trigger a wider cross-currency basis across currencies over time.

Overall, the major contribution of our paper is uncovering the hitherto unknown relationship between inflation differential and CIP deviations. To our knowledge, this is the first study in the more liquid G10 currency derivatives markets to initiate discussions along this path[1]. Our study also adds to the sparse but growing evidence that inflation is a priced risk factor in the financial market. Examining the equities market, Boons, Duarte, de Roon, & Szymanowska (2019) use a consumption-based asset pricing model to show that inflation risk is priced in stock returns and argue for evidence of time variation in inflation risk premia in the cross-section and aggregate stock market. In this paper, we use a simple allied monetary-based model backed by empirical evidence to document that inflation differential is a priced risk factor in the cross-currency basis markets for G10 currencies viz-a-viz the dollar, a market where deviations from CIP writ large.

The rest of this article is organized as follows. Section 2 presents a simple stylized empirical framework on which the empirical analysis is built. Section 3 presents the data and empirical analysis, Section 4 presents additional robustness checks. Section 5 discusses empirical results. Section 6 presents inflation differential as a priced risk factor for the basis. We conclude in Section 7.

2. Empirical Framework

Drawing on a modified Taylor rule a' la' Amano and Ambler (2014) and Engel *et al.* (2017), in this section, we provide a stylized empirical framework where we express CIP deviations as a function of inflation differential and relative economic performance. The subsequent empirical results in the next section reveals that higher inflation differential and stronger economic performance go hand-in-hand with wider CIP

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[1] In an earlier study, Cheung and Qian (2011) have documented a link between inflation volatility and CIP deviations for the Chinese Renminbi. Our work differs markedly from their work in aim and scope. First, while they study CIP deviations in China, our work instead focuses on the 10 most liquid currencies. Second and importantly, while they use inflation volatility as one of their economic stability variables, here we present a formal modelling framework that uses inflation differentials to study the behavior of CIP deviations over time.

deviations post Global Financial Crisis (GFC). The results are robust to the inclusion of major covariates that have been established in the literature as strong drivers of CIP deviations.

2.1 A Simple Stylized Empirical Framework

In general, when CIP condition holds, CIP deviations and hence the cross-currency basis are zero. Thus,

$$f_{kt,t+1} - s_t = i_{kt,t+1} - i^{US}_{t,t+1} \qquad (1a)$$

where $f = \log F$ and $s = \log S$ are the forward and spot exchange rate per dollar; i and i^{US} are interest rates in the foreign (non-USD) and USD currencies, and $k = 1, \ldots . N$ and $t = 1 \ldots, T$ are the country and time dimensions. The corresponding regression specification is:

$$f_{kt,t+1} - s_{kt} = \beta_0 + \beta_1\left(i_{kt,t+1} - i^{US}_{t,t+1}\right) + \varepsilon_{kt,t+1} \qquad (1b)$$

With deviations from CIP, however, $f_{kt,t+1} - s_{kt} \neq i_{kt,t+1} - i^{US}_{t,t+1}$, and there is a basis swap spread $xccy_{kt,t+1}$, added to the non-dollar interest leg, such that (1a) becomes:

$$f_{kt,t+1} - s_{kt} = \left(i_{kt,t+1} + xccy_{kt,t+1}\right) - i^{US}_{t,t+1}$$

or

$$xccy_{kt,t+1} = \left(f_{kt,t+1} - s_t\right) - \left(i_{kt,t+1} - i^{US}_{t,t+1}\right) \qquad (1c)$$

Subtracting $i_{kt,t+1} - i^{US}_{kt,t+1}$ from both sides of (1b) and combining with the expression in (1c), we get:

$$xccy_{kt,t+1} = \beta_0 + (\beta_1 - 1)\left(i_{kt,t+1} - i^{US}_{kt,t+1}\right) + \varepsilon_{kt,t+1} \qquad (1d)$$

Next, we obtain a relation expressing changes in cross-currency basis in terms of inflation differential and relative economic performance, where inflation differential is defined as changes in the difference in consumer price index (log CPI) between country k and the US, while relative economic performance represents changes in the difference in purchasing manager's index (PMI) between country k and the US.

In a recent study, Engel *et.al* (2018) specify a model in which a Taylor rule determines monetary policy while Amano and Ambler (2014) develop a modified Taylor rule based on a price-targeting framework. Following these studies, we can write the US nominal interest rate as

$$i^{US}_{kt,t+1} = \gamma^{US}_0 + \gamma^{US}_1 p^{US}_{t+1} + \gamma^{US}_2 y^{US}_{t+1},\ \gamma^{US}_l > 0,\ l = 1{,}2 \qquad (2a)$$

Where, in our specification, p^{US}_{t+1} and y^{US}_{t+1} are the CPI (in logs) and PMI, a high-frequency measure of economic sentiment or output performance.

Suppose a similar relation holds in the foreign country, k, we have

$$i_{kt,t+1} = \gamma_0 + \gamma_1 p_{kt+1} + \gamma_2 y_{kt+1}, \qquad \gamma_l > 0, l = 1,2 \qquad (2b)$$

Subtracting (2a) from (2b), we get

$$i_{kt,t+1} - i_{kt,t+1}^{US} = \left(\gamma_0 - \gamma_0^{US}\right) + \left(\gamma_1 p_{kt+1} - \gamma_1^{US} p_{t+1}^{US}\right) + \left(\gamma_2 y_{kt+1} - \gamma_2^{US} y_{t+1}^{US}\right) \qquad (2c)$$

which, together with (1d), yields

$$xccy_{kt,t+1} = \beta_0 + (\beta_1 - 1)\left(\gamma_0 - \gamma_0^{US}\right) + (\beta_1 - 1)\left(\gamma_1 p_{kt+1} - \gamma_1^{US} p_{t+1}^{US}\right) + (\beta_1 - 1)\left(\gamma_2 y_{kt+1} - \gamma_2^{US} y_{t+1}^{US}\right) + \varepsilon_{kt,t+1} \quad \text{(3a)}$$

Assume parameters are identical, we have $\gamma_l = \gamma_l^{US}$, $l = 0,1,2$, and

$$xccy_{kt,t+1} = \beta_0 + A_1\left(p_{kt+1} - p_{t+1}^{US}\right) + A_2\left(y_{kt+1} - y_{t+1}^{US}\right) + \varepsilon_{kt,t+1} \qquad (3b)$$

where $A_1 = \gamma_1(\beta_1 - 1)$ and $A_2 = \gamma_2(\beta_1 - 1)$.

First difference of $(3b)$ yields

$$\Delta xccy_{kt,t+1} = A_0 + A_1 \Delta\left(p_{kt+1} - p_{t+1}^{US}\right) + A_2 \Delta\left(y_{kt+1} - y_{t+1}^{US}\right) + \varepsilon_{kt,t+1} \qquad (4a)$$

which is our baseline regression. Including other control variables, we have

$$\Delta xccy_{kt,t+1} = A_0 + A_1 \Delta\left(p_{kt+1} - p_{t+1}^{US}\right) + A_2 \Delta\left(y_{kt+1} - y_{t+1}^{US}\right) + \boldsymbol{B} CONTROLS + \varepsilon_{kt,t+1} \qquad (4b)$$

where $\Delta\left(p_{kt+1} - p_{t+1}^{US}\right)$, which are changes in log CPI differential, corresponds to inflation differential between country k and the US, while $\Delta\left(y_{kt+1} - y_{t+1}^{US}\right)$, which represents changes in PMI differential, corresponds to relative economic performance between country k and the US, and $CONTROLS$ is a vector of covariates or control variables that have been identified in the literature as potential drivers of cross-currency basis swap spreads while $\boldsymbol{B}$ contains the estimated coefficients on the corresponding $CONTROLS$. The $CONTROLS = (\Delta Dollar_t, Bilateral_{kt}, \Delta lnVIX_t, \Delta ImpliedVol_{kt}, \Delta 25DRR_{kt}, \Delta YieldSpread_{kt}, \Delta(TS_{kt} - TS_t^{US})$, where $\Delta Dollar_t$ stands for changes in the US trade-weighted broad dollar index. The base currency is US dollars, so an increase in the broad dollar, i.e. $\Delta Dollar_t > 0$ denotes dollar appreciation. $Bilateral_{kt}$ is the nominal exchange rate measured in the number of units of each G10 currency per unit of the US dollar, $\Delta lnVIX_{it}$ is the log changes in the implied volatility of S&P 500 index options to control for changes in global risk sentiment, $\Delta ImpliedVol_{kt}$ represents changes in the implied volatility of FX to capture the risk-neutral volatility of FX movements, $\Delta 25RR_{it}$ represent changes in 25-delta FX option risk reversals (that is, the difference between the volatility of call and put price at the 25 delta, out of money) to control for the cost of hedging against the appreciation of the base currency (dollar appreciation). A high value of $\Delta 25RR_{it} > 0$ implies the cost of hedging against dollar appreciation has increased because the market is now pricing in a higher likelihood of a broad dollar appreciation. $\Delta YieldSpread_{kt}$ represent changes in the treasury yield spread at the 10-year maturity while $\Delta(TS_{kt} - TS_t^{US})$ denote changes in the term spread different (10-year over 2-year). Both control for the potential divergence in monetary policy between each foreign country and the US. All variables are in first difference and stationary, so the problem of non-stationarity does not arise.

Notice that the specification in (4a-b), irrespective of the controls included, requires that $\frac{A_1}{A_2} > 0$ because $\gamma_l > 0, l = 1,2$ from (2b), and $A_1 = \gamma_1(\beta_1 - 1)$ and $A_2 = \gamma_2(\beta_1 - 1)$ means $\frac{A_1}{A_2} = \frac{\gamma_1(\beta_1-1)}{\gamma_2(\beta_1-1)} > 0$ for $|\gamma_l| < \infty$. Now, $\frac{A_1}{A_2} > 0$ suggests that either i) $A_1 < 0$ and $A_2 < 0$ or ii) $A_1 > 0$ and $A_2 > 0$. That is, our specification requires inflation differential and relative economic performance to have similar effects, but of possibly different magnitude, on the basis. Both cases are feasible and theoretically possible. The case for which $A_1 < 0$ and $A_2 < 0$ correspond to a wider basis emanating from an increase in inflation differential and a rise in relative economic performance in country k relative to the US. The outcome $A_1 < 0$ could occur, for instance, to the extent that a rise in inflation differential in country k induces currency depreciations and broad dollar appreciations. Studies such as Avdjiev *et al.* (2019) have documented a relationship where a rise in broad dollar strength leads to wider basis. So, we would expect the basis to widen if higher inflation differential triggers a rise in broad dollar strength. Looking at the scenario where $A_2 < 0$, studies such as Chen (2010) have shown that credit spreads tend to widen in response to poor economic performance. Thus, to the extent that better economic sentiment lowers credit spreads, we would expect the lower spreads to lessen borrowing costs, accelerate borrowings in currency k and raise demand for dollar hedges. In this instance, the cross-currency basis would widen if demand for dollar hedges dominates in the transmission mechanism.

The condition $A_1 > 0$ and $A_2 > 0$ corresponds to the instance where both a rise in inflation differential and improvements in economic conditions in country k relative to the US lead to tighter cross-currency basis that lessens CIP deviations. $A_1 > 0$ could occur, for example, if a rise in inflation differential induces higher interest rate increases that prevent currency depreciations (or prevent broad dollar appreciations, leading to a tighter basis) and/or raise overall borrowing costs in currency k, which lowers issuance in currency k and hence reduces demand for dollar hedges, causing the basis to tighten. $A_2 > 0$ could occur if an improvement in economic sentiment in country k relative to the US releases the counter-cycle nature of the dollar, causing the broad dollar index to in fact weaken, or if the improved economic performance is sustained and induces a flow of supply of dollar hedges to country $k's$ asset, which overshadows any demand for dollar hedges and causes the basis to tighten. In the next section, we estimate the baseline regression and control for other drivers of the cross-currency basis.

3. Data and Empirical Analysis

In this section, we present information on the data utilized for the empirical analysis that examines the empirical merits of the proposed drivers of the cross-currency basis. After presenting information on the data, we graphically illustrate the relationship between the basis and the proposed drivers. Finally, we perform formal econometrical analysis to establish the relationship between these drivers and the basis.

3.1 Data

Our analysis is based on data obtained from Bloomberg and our sample period ranges from January 2010 to January 2019. We focus on the dollar cross-currency basis associated with the G10 currencies -Australian dollar, Canadian dollar, the Swiss franc, the Danish krone, the euro, the British pound, the Japanese yen, the Norwegian krone, New Zealand and the Swedish krona. All data are sourced from Bloomberg. Our sample period ranges from January 2010 to December 2018. Our regressions are based on monthly frequency as this is the highest possible frequency for which economic data such as PMI and CPI are reported. The variables and their sources are reported in Table 1a below.

Table 1a: Data and Sources

Variable	Source
Dollar Cross-currency Basis Swap Spread (*xccy*)	Bloomberg
Consumer Price Index (*CPI*)	Bloomberg, FRED
Purchasing Manager Index (*PMI*)	Bloomberg
Trade-Weighted Broad Dollar Index (*Dollar*)	Bloomberg, FRED
Volatility Index (*VIX*)	Bloomberg
Bilateral Exchange Rate (*Bilateral*)	Bloomberg
Implied Volatility of FX Options (*Imply Vol*)	Bloomberg
25-Delta FX Options Risk Reversal (*25DRR*)	Bloomberg
10-Year US Treasury Yield	Bloomberg
10-Year Foreign Country Treasury Yield	Bloomberg
2-Year US Treasury Yield	Bloomberg
2-Year Foreign Country Treasury Yield	Bloomberg
Libor-OIS Spreads	Bloomberg

Note: In line with the literature, the cross-currency basis are the 3-month and the 5-year cross currency bases in percentage points for the period between January 2010 and December 2018. We exclude Australia and New Zealand because their CPI variable for inflation computation are reported only on a quarterly frequency which is a lower frequency than the preferred monthly frequency. For the rest countries, all variables are reported at the monthly frequency. In Appendix A3i and A3ii, we show that our results are mostly robust when we use quarterly frequency data, especially for the 5-year basis

Table 1b displays summary statistics for the G10 cross-currency dollar bases. In general, it turns out that negative levels of the bases have, on average, dominated across currencies over time. In simple terms, this implies that the US dollar is taken as more desirable than the negative-basis currencies. As such, holders of these currencies are willing to forfeit some potential returns and accept a discount (lower interest) to provide their own currencies in the swap market. On the other hand, they pay a premium to access dollar liquidity, which means that dollar liquidity is more expensive in the swap market for holders of more negative-basis currencies. Further, a negative basis has two main implications, among others. First, dollar-based investors, with access to investible dollar capital, can, on average, generate higher dollar returns from investments in foreign bonds than investments in domestic dollar-denominated bonds. These higher returns are possible by purchasing foreign bonds and hedging the stream of interest into US dollar Libor using cross-currency swaps. Second, ceteris paribus, foreign entities can borrow their own currencies at a lower cost via cross-currency swaps compared to borrowing directly in their domestic cash market. This is possible because, when the basis is negative, possession of dollars enables foreign entities to access their negative-basis currencies more cheaply via cross-currency swaps.

Meanwhile, currencies with positive dollar basis i.e. AUD, NZD have an opposite interpretation. Holders of positive-basis currencies consider the dollar as less special relative to their own currencies and hence can pay a discount to access dollar funding in the swap market. On the other hand, dollar holders willingly accept this discount in order to access these positive-basis currencies even at a premium. Thus, agents with positive-basis currencies can raise dollars more cheaply via cross-currency swaps by funding with the positive-basis currencies than by borrowing dollars directly in the dollar cash market. Similarly, foreign entities with positive-basis currencies can earn higher returns in these currencies by purchasing US bonds and hedging the stream of interests into their currencies instead of directly purchasing bonds denominated in their currencies.

Table 1b: Summary Statistics

	5-year basis		**3-month basis**	
Currency	**Mean**	**Std dev**	**Mean**	**Std dev**
AUD	24.81	4.06	3.98	15.22
CAD	5.20	10.11	-9.94	13.78
CHF	-34.98	17.97	-22.69	19.78
DKK	-45.32	22.95	-57.04	32.76
EUR	-27.32	17.22	-30.23	26.24
GBP	-5.09	7.44	-13.67	19.36
JPY	-62.12	16.73	-39.97	18.07
NOK	-17.45	11.43	-32.67	25.83
NZD	26.67	14.12	9.67	11.11
SEK	-7.57	9.36	-19.32	15.14

Table 1b displays summary statistics of the mean and standard deviation of the cross-currency basis swap spreads expressed in basis points. Source: Bloomberg. Author estimations

Furthermore, we also present summary statistics of the main variables, inflation differential and relative economic performance, that enter our regressions. Table 1c below displays the summary statistics of our variables of interest - the inflation differential and relative economic performance – and maps the mean and standard deviation of both variables to their corresponding countries. A positive average inflation differential suggests that average inflation in country i has been higher than the corresponding average inflation in the US over the sample period. A positive relative economic performance implies that on average the economy performs increasingly better from period to period in country i relative to the US over the sample period.

Combining Tables 1b and 1c, the summary statistics of our variables of interest provides some interesting preliminary insights. First, it shows that high or more positive average inflation differential corresponds to countries with wider, more negative or least positive average bases, i.e. CHF, JPY, DKK, EUR and SEK to some extent, whereas countries with low or more negative average inflation differential are often those with tighter, more positive or least negative average bases, i.e. AUD, CAD, GBP and NZD. Second, the summary statistics also provide some evidence that countries with positive average relative economic performance tend to have more negative average bases, i.e. CHF, DKK and EUR, while those with negative average relative economic performance, to some extent, tend to have positive average bases, i.e. SEK, NZD and GBP.

In sum, among others, the summary statistics reveal an important stylized idea: On average, countries with positive or higher inflation differential relative to the US seem to be among those with wider or more negative bases while those with negative or lower inflation differential tend to be among those with tighter or more positive bases over the sample period. Together with other empirical analyses, these preliminary insights and stylized ideas would formally be developed and rigorously tested in the subsequent sections of this article.

Table 1c: Summary statistics for main variables of interest

	Inflation Differential (%) $\Delta(\boldsymbol{p}_{kt} - \boldsymbol{p}_{kt}^{US})$		**Relative Economic Performance (%)** $\Delta(\boldsymbol{y}_{kt} - \boldsymbol{y}_{t}^{US})$	
Currency	**Mean**	**Std dev**	**Mean**	**Std dev**
AUD	-0.018	0.013	0.031	3.341
CAD	0.002	0.307	0.030	7.360
CHF	0.151	0.395	0.043	2.462
DKK	0.042	0.409	0.097	5.149
EUR	0.021	0.479	0.012	1.663
GBP	-0.048	0.396	0.011	2.252
JPY	0.110	0.362	0.002	3.628
NOK	-0.039	0.498	-0.029	2.146
NZD	-0.000	0.012	-0.022	3.018
SEK	0.048	0.427	-0.058	2.387

Source: Bloomberg. Author estimations. Table 1c displays summary statistics of the mean and standard deviation of the inflation differential and relative economic performance. Except for Australia and New Zealand price level data which are only available quarterly, others are monthly changes. Inflation differential is change in log price differential while relative economic performance is change in PMI differential, where for each variable each differential is taken in each country relative to the US.

Figures 1a and 1b below plot the mean inflation differential (in red) and relative economic performance (in yellow) respectively. When the yellow line rises, relative economic performance improves in favour of the foreign country; when the red line goes up, inflation differential rises which means inflation in the foreign country increases relative to the US. The green line plots the mean dollar cross-currency basis for the liquid currencies considered[2].

Figure 1a: Inflation differential and the cross-currency basis

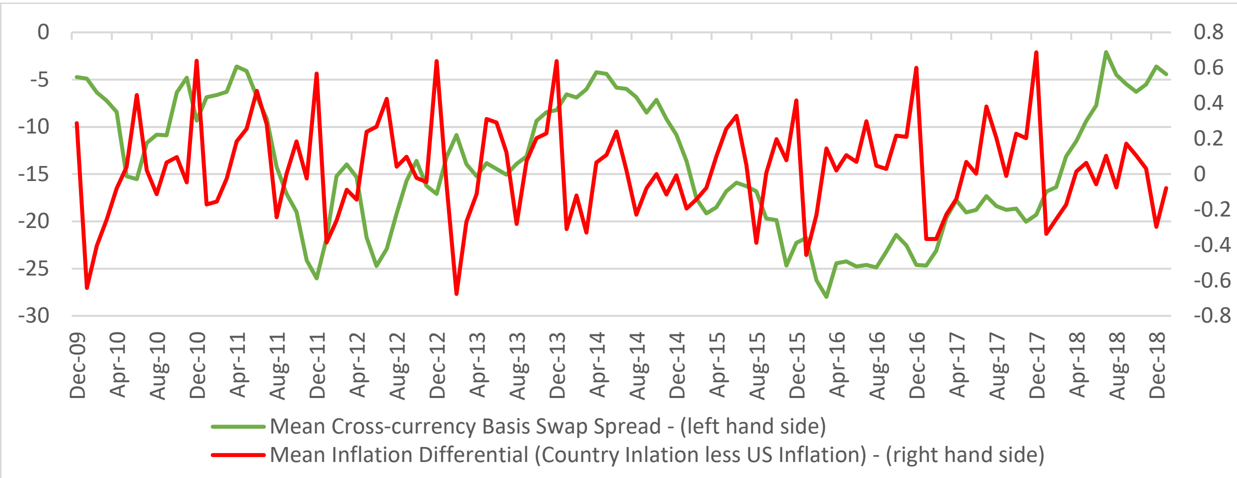
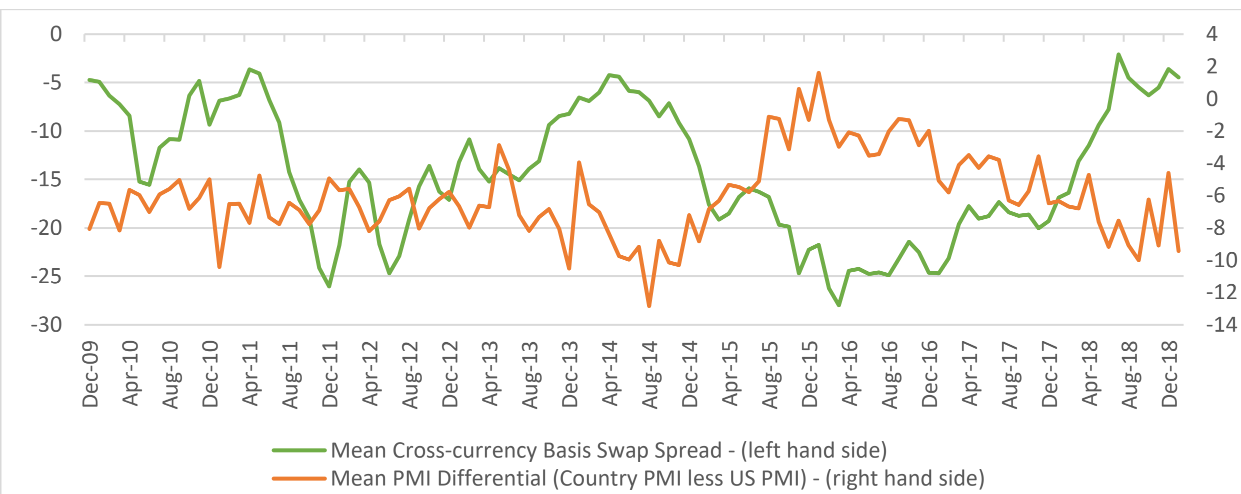


Figure 1b: Relative economic performance and the cross-currency basis



Source: Authors, 2020 based on Bloomberg Data.

[2] We first exclude Australia and New Zealand because both countries only report CPI inflation data quarterly, which is of a lower frequency and at odds with the rest countries that report economic data at the highest possible frequency - monthly. In Appendix A3i and A3ii, we show that our results are mostly when we use quarterly frequency data, especially for the 5-year basis.

From figures 1a and 1b, we see that the basis generally moves in the opposite direction of inflation differential and relative economic performance. When inflation differential rises, the basis goes down which means it becomes more negative (as in figure 1a) and when relative economic performance increases (as in figure1b), the basis goes down too; it becomes more negative which means CIP deviations worsen.

3.2 Empirical Analysis

We now perform formal empirical analysis to establish the relationship among cross-currency basis, inflation differential and relative economic performance. In our baseline regression, we estimate the specification in (4a) (without the controls) which proposes two potential drivers of changes in the basis. We perform the analysis for the post GFC crisis period - 2010 to 2018[3]. In subsequent robustness checks, we follow the procedure in Avdjiev *et.al* (2019) and include other control variables which have been identified as potential drivers of the basis in the literature. These variables include: 1) trade-weighted dollar index and bilateral exchange rate, to evaluate the effect of dollar strength on the basis; 2) VIX index to control for global risk sentiment; 3) implied volatility of FX options to control for risk-neutral volatility of FX movements, and 25-delta risk reversal of FX options to control for the cost of hedging against large depreciations; 4) 10-year yield spread – that is, spread of the 10-year Treasury yield of country *k* over the US 10-year Treasury yield, and 5) spread of foreign and US Treasury term spread, where the term spread is the slope of the Treasury yield curve of 10-year versus 2-year. Our full results are reported in Tables 2a and 2b. In final robustness checks, we also include Libor-OIS as controls in the regressions and report results in Tables 2c and 2d.

[3] Although not our focus or aim in this paper, we also report results for the sample period – 2002 to 2018, pre-crisis – 2002 to 2006, and GFC crisis – 2007 to 2009 in the appendix. As CIP deviations were generally close to zero in the pre-crisis era, relative economic performance and inflation differential had no significant economic impact on the basis in this era. Also, all the commonly cited potential drivers of the basis do not have any power to driver changes in the basis in the pre-crisis period. During the GFC period when noticeable deviations from CIP emerged, the potential drivers of the basis, which had immaterial impact prior to the crisis, began to show importance and significance. After controlling for other notable drivers of the basis, the effect of relative economic performance and inflation differential on the basis is negative. The broad dollar strength and general risk sentiment, measured by VIX, are negatively linked to the basis.

Table 2a: Regression results of the 5-year and 3-month cross-currency basis

5-year basis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta(p_{kt} - p_t^{US})$	-1.102***	-1.108***	-1.255***	-1.258***	-1.145***	-1.168***	-1.133***	-1.064***
	(0.331)	(0.314)	(0.313)	(0.313)	(0.311)	(0.311)	(0.311)	(0.308)
$\Delta(y_{kt} - y_t^{US})$	-0.103***	-0.098***	-0.092***	-0.093***	-0.090***	-0.093***	-0.092***	-0.086***
	(0.028)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.025)
$\Delta Dollar_t$		-0.988***	-0.949***	-0.937***	-0.839***	-0.806***	-0.748***	-0.658***
		(0.099)	(0.099)	(0.102)	(0.103)	(0.104)	(0.108)	(0.109)
$\Delta lnVIX_t$			-2.841***	-2.886***	-1.519***	-1.516***	-1.735***	-1.494***
			(0.687)	(0.693)	(0.757)	(0.755)	(0.763)	(0.757)
$\Delta Bilateral_{kt}$				-0.081	-0.085	-0.052	-0.009	-0.010
				(0.155)	(0.154)	(0.154)	(0.156)	(0.154)
$\Delta ImpliedVol_{kt}$					-0.650***	-0.597***	-0.629***	-0.597***
					(0.152)	(0.154)	(0.154)	(0.153)
$\Delta 25DRR_{kt}$						-0.792***	-0.775***	-0.708***
						(0.371)	(0.371)	(0.367)
$\Delta YieldSpread_{kt}$							2.257***	5.021***
							(1.167)	(1.318)
$\Delta(TS_{kt} - TS^{US})$								-5.539***
								(1.273)
Observations	857	857	857	857	857	857	857	857
R^2	0.027	0.120	0.145	0.146	0.164	0.168	0.172	0.190
Fixed effects included?	No	No	No	No	No	No	No	No

3-month basis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta(p_{kt} - p_t^{US})$	-0.994***	-0.999***	-1.250***	-1.252***	-1.181***	-1.188***	-1.203***	-1.133***
	(0.489)	(0.482)	(0.480)	(0.480)	(0.481)	(0.482)	(0.483)	(0.482)
$\Delta(y_{kt} - y_t^{US})$	-0.075*	-0.071*	-0.061	-0.061	-0.059	-0.060	-0.061	-0.055
	(0.041)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)
$\Delta Dollar_t$		-0.769***	-0.702***	-0.697***	-0.635***	-0.625***	-0.650***	-0.559***
		(0.153)	(0.151)	(0.156)	(0.160)	(0.162)	(0.168)	(0.171)
$\Delta lnVIX_t$			-4.862***	-4.881***	-4.023***	-4.022***	-3.928***	-3.683***
			(1.054)	(1.063)	(1.171)	(1.172)	(1.185)	(1.184)
$\Delta Bilateral_{kt}$				-0.034	-0.037	-0.026	-0.044	-0.045
				(0.238)	(0.238)	(0.239)	(0.242)	(0.241)
$\Delta ImpliedVol_{kt}$					-0.408*	-0.391*	-0.377	-0.345
					(0.235)	(0.238)	(0.240)	(0.239)
$\Delta 25DRR_{kt}$						-0.259	-0.266	-0.198
						(0.576)	(0.576)	(0.574)
$\Delta YieldSpread_{kt}$							-0.967	1.841
							(1.814)	(2.062)
$\Delta(TS_{kt} - TS^{US})$								-5.627***
								(1.992)
Observations	857	857	857	857	857	857	857	857
R^2	0.008	0.037	0.060	0.060	0.064	0.064	0.064	0.073
Fixed effects included?	No	No	No	No	No	No	No	No

Note *, **, *** 10%, 5% and 1% significance respectively while standard errors in parenthesis are robust. Currency fixed effects are excluded. This table shows regression results of monthly changes in the 5-year and 3-month Libor cross currency basis on changes in log CPI differential $\Delta(p_{kt} - p_{kt}^{US})$ (that is, inflation differential) and changes in PMI differential $\Delta(y_{kt} - y_t^{US})$, (relative economic performance) and other controls. The dependent variables are the monthly changes in the 5-year and 3-month Libor cross-currency basis. The regressors of interest are the inflation differential $\Delta(p_{kt} - p_{kt}^{US})$ and relative economic performance $\Delta(y_{kt} - y_t^{US})$. The other independent variables (controls) are: $\Delta Dollar_t$, monthly change in the federal reserve board (FRB) trade-weighted broad dollar index, where $\Delta Dollar_t$>0 implies broad dollar appreciation ; $\Delta Bilateral_{kt}$, monthly change in the bilateral spot exchange rate of the local currency per dollar so that $\Delta Bilateral_{kt} > 0$ implies appreciation of the dollar against the local currency; $\Delta lnVIX_t$, monthly change in the log of volatility index (VIX), $\Delta ImpliedVol_{kt}$ change in the log of implied volatility on 3-month at-the-money currency options; $\Delta 25DRR_{kt}$, monthly change in the 25-delta risk reversal; $\Delta YieldSpread_{kt}$ is the monthly change in yield spread; $\Delta(TS_{kt} - TS^{US})$ is the change in the term spread (TS), that is, the change in the difference between the foreign and US Treasury term spreads (10-year over 2-year).

Sources: Bloomberg; FRED, author's calculations

Table 2b: Regression results of the 5-year and 3-month cross-currency basis: Further robustness (currency fixed effects included in specifications)

5-year basis	1	2	3	4	5	6	7	8
$\Delta(p_{kt}-p_t^{US})$	-1.105***	-1.112***	-1.262***	-1.266***	-1.150***	-1.172***	-1.135***	-1.071***
	(0.337)	(0.319)	(0.318)	(0.318)	(0.316)	(0.316)	(0.316)	(0.313)
$\Delta(y_{kt}-y_t^{US})$	-0.104***	-0.098***	-0.093***	-0.093***	-0.090***	-0.093***	-0.092***	-0.087***
	(0.028)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)
$\Delta Dollar_t$		-0.988***	-0.949***	-0.937***	-0.839***	-0.806***	-0.747***	-0.656***
		(0.100)	(0.099)	(0.102)	(0.104)	(0.105)	(0.109)	(0.110)
$\Delta lnVIX_t$			-2.843***	-2.886***	-1.518***	-1.514***	-1.738***	-1.498***
			(0.690)	(0.695)	(0.760)	(0.758)	(0.765)	(0.759)
$\Delta Bilateral_{kt}$				-0.078	-0.083	-0.050	-0.005	-0.006
				(0.157)	(0.155)	(0.156)	(0.157)	(0.155)
$\Delta ImpliedVol_{kt}$					-0.650***	-0.598***	-0.630***	-0.597***
					(0.153)	(0.154)	(0.155)	(0.153)
$\Delta 25DRR_{kt}$						-0.792***	-0.775***	-0.706***
						(0.372)	(0.372)	(0.368)
$\Delta YieldSpread_{kt}$							2.307**	5.120***
							(1.174)	(1.327)
$\Delta(TS_{kt}-TS^{US})$								-5.604***
								(1.280)
Observations	857	857	857	857	857	857	857	857
R^2	0.028	0.130	0.147	0.147	0.165	0.170	0.173	0.192
Fixed effects included?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

3-month basis	1	2	3	4	5	6	7	8
$\Delta(p_{kt}-p_t^{US})$	-1.002***	-1.007***	-1.265***	-1.266***	-1.194***	-1.201***	-1.216***	-1.151***
	(0.497)	(0.490)	(0.488)	(0.488)	(0.489)	(0.490)	(0.491)	(0.489)
$\Delta(y_{kt}-y_t^{US})$	-0.075*	-0.071*	-0.061	-0.061	-0.059	-0.060	-0.060	-0.055
	(0.041)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)
$\Delta Dollar_t$		-0.769***	-0.702***	-0.698***	-0.637***	-0.627***	-0.650***	-0.557***
		(0.153)	(0.152)	(0.157)	(0.160)	(0.162)	(0.169)	(0.171)
$\Delta lnVIX_t$			-4.867***	-4.880***	-4.027***	-4.026***	-3.939***	-3.695***
			(1.058)	(1.067)	(1.176)	(1.176)	(1.190)	(1.188)
$\Delta Bilateral_{kt}$				-0.023	-0.027	-0.016	-0.033	-0.034
				(0.240)	(0.240)	(0.241)	(0.244)	(0.243)
$\Delta ImpliedVol_{kt}$					-0.406*	-0.389*	-0.376	-0.343
					(0.236)	(0.239)	(0.241)	(0.240)
$\Delta 25DRR_{kt}$						-0.258	-0.265	-0.195
						(0.578)	(0.578)	(0.576)
$\Delta YieldSpread_{kt}$							-0.895	1.981
							(1.826)	(2.078)
$\Delta(TS_{kt}-TS^{US})$								-5.729**
								(2.004)
Observations	857	857	857	857	857	857	857	857
R^2	0.009	0.038	0.061	0.061	0.065	0.065	0.065	0.074
Fixed effects included?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note *, **, *** 10%, 5% and 1% significance respectively. Standard errors in parenthesis are robust. Currency fixed effects are included. This table shows regression results of monthly changes in the 5-year and 3-month Libor cross currency basis on changes in log CPI differential $\Delta(p_{kt}-p_{kt}^{US})$ (that is, inflation differential) and changes in PMI differential $\Delta(y_{kt}-y_t^{US})$, (relative economic performance) and other controls. The dependent variables are the monthly changes in the 5-year and 3-month Libor cross-currency basis. The regressors of interest are the inflation differential $\Delta(p_{kt}-p_{kt}^{US})$ and relative economic performance $\Delta(y_{kt}-y_t^{US})$. The other independent variables (controls) are: $\Delta Dollar_t$, monthly change in the federal reserve board (FRB) trade-weighted broad dollar index, where $\Delta Dollar_t$>0 implies broad dollar appreciation ; $\Delta Bilateral_{kt}$, monthly change in the bilateral spot exchange rate of the local currency per dollar so that $\Delta Bilateral_{kt} > 0$ implies appreciation of the dollar against the local currency; $\Delta lnVIX_t$, monthly change in the log of volatility index (VIX), $\Delta ImpliedVol_{kt}$ change in the log of implied volatility on 3-month at-the-money currency options; $\Delta 25DRR_{kt}$, monthly change in the 25-delta risk reversal; $\Delta YieldSpread_{kt}$ is the monthly change in yield spread; $\Delta(TS_{kt}-TS^{US})$ is the change in the term spread (TS), that is, the change in the difference between the foreign and US Treasury term spreads (10-year over 2-year). Standard errors in parenthesis are robust. Currency fixed effects are included in all specifications.

Sources: Bloomberg; FRED, author's calculations

4. Additional Robustness Checks

It is well known among researchers and practitioners and in the literature that dollar-funding liquidity stress, which often morphs into notable deviations from CIP (i.e. wider basis) in the money markets, is reflected in the Libor-OIS spread. The Libor-OIS spread is a measure of the degree of financial strain in the banking system. Because it is an indication of banks' perception of the creditworthiness of other financial institutions and the availability of funds for lending purposes, it reveals the additional premium over the OIS (overnight indexed swap) that major banks demand (or pay) in order to lend to (or borrow from) one another and to other financial institutions. When this spread is high, especially when the high spread coincides with lower OIS rate, this is usually an indication of high dollar-funding liquidity stress as major banks become more reluctant to lend, and thus demand a higher premium to lend, due to heightened fear of default probability or elevated counterparty risk. This indicates companies are having trouble raising finance and limits the ability to take on leverage. Conversely, a low Libor-OIS spread indicates that dollar-funding liquidity stress is low, which implies a healthy level of dollar liquidity in the market.

In view of the foregoing, we include changes in Libor-OIS spread $\Delta LOIS_{kt}$ as an additional regressor into our regressions to i) circumvent the omitted variable bias that could emanate from excluding Libor-OIS spread given its importance documented in previous studies – and ii) to control for changes in dollar-funding liquidity stress. The results are reported in the Table 2c below.

Table 2c: Additional regression results for the 5-year and 3-month cross-currency basis

	5-year basis		3-months basis	
	(1)	(2)	(1)	(2)
$\Delta(p_{kt} - p_{kt}^{us})$	-0.874***	-0.933***	-1.034**	-1.075**
	(0.309)	(0.314)	(0.484)	(0.494)
$\Delta(y_{kt} - y_{yt}^{us})$	-0.084***	-0.086***	-0.054	-0.055
	(0.025)	(0.025)	(0.040)	(0.040)
$\Delta Dollar_t$	-0.635***	-0.656***	-0.549***	-0.557***
	(0.108)	(0.109)	(0.170)	(0.171)
$\Delta lnVIX_t$	-0.639	-0.703	-3.218***	-3.258***
	(0.791)	(0.792)	(1.240)	(1.246)
$\Delta Billateral_{kt}$	-0.007	-0.003	-0.043	-0.032***
	(0.154)	(0.154)	(0.241)	(0.243)
$\Delta ImpliedVol_{kt}$	-0.615***	-0.578***	-0.350	-0.332
	(0.152)	(0.153)	(0.238)	(0.240)
	-0.586	-0.560	-0.127	-0.115

$\Delta 25DRR_{kt}$				
	(0.369)	(0.369)	(0.578)	(0.580)
$\Delta YieldSpread_{kt}$	3.994***	4.593***	1.344	1.692
	(1.308)	(1.329)	(2.051)	(2.092)
$\Delta(TS_{kt} - TS^{us})$	-4.955***	-5.524***	-4.955***	-5.685
	(1.253)	(1.273)	(1.965)	(2.004)
$\Delta LOIS_{kt}$	-0.078***	-0.079***	-0.043	-0.043
	(0.024)	(0.024)	(0.037)	(0.037)
Observations	857		857	857
R^2	0.195	0.202	0.074	0.075
Fixed effects included?	No	Yes	No	Yes

Note *, **, *** 10%, 5% and 1% significance respectively while standard errors in parenthesis are robust. Currency fixed effects are excluded. This table shows regression results of monthly changes in the 5-year and 3-month Libor cross currency basis on changes in log CPI differential $\Delta(p_{kt} - p_{ktUS})$ (that is, inflation differential) and changes in PMI differential $\Delta(y_{kt} - y_{tUS})$, (relative economic performance) and other controls. The dependent variables are the monthly changes in the 5-year and 3-month Libor cross-currency basis. The regressors of interest are the inflation differential $\Delta(p_{kt} - p_{ktUS})$ and relative economic performance $\Delta(y_{kt} - y_{tUS})$. The other independent variables (controls) are: $\Delta Dollar_t$, monthly change in the federal reserve board (FRB) trade-weighted broad dollar index, where $\Delta Dollar_t$>0 implies broad dollar appreciation ; $\Delta Bilateral_{kt}$, monthly change in the bilateral spot exchange rate of the local currency per dollar so that $\Delta Bilateral_{kt}$>0 implies appreciation of the dollar against the local currency; $\Delta lnVIX_t$, monthly change in the log of volatility index (VIX), $\Delta ImpliedVol_{kt}$ change in the log of implied volatility on 3-month at-the-money currency options; $\Delta 25DRR_{kt}$, monthly change in the 25-delta risk reversal; $\Delta YieldSpread_{kt}$ is the monthly change in yield spread; $\Delta(TS_{kt} - TS_{US})$ is the change in the term spread (TS), that is, the change in the difference between the foreign and US Treasury term spreads (10-year over 2-year), and $\Delta LOIS_{kt}$ is the change in Libor-OIS spread.

The results in Table 2c display the outcome of the additional robustness checks, with the impact of changes in Libor-OIS spread on the basis also displayed. Where significant, the results generally provide evidence of the negative association between both the basis and Libor-OIS indicators as is often reported in the literature. More importantly though, even with the inclusion of the new variable, Libor-OIS, together with the other controls to our regression, our main results remain robustly unchanged. The results also record some improvement in explanatory power via an increase in R^2 from the inclusion of the additional control variable. In a nutshell, the negative effect of inflation differential on changes in the basis is robust even to the inclusion of an important control variable, Libor-OIS spread, which a vast number of previous studies have found to be influential in the cross-currency basis swap market.

Meanwhile, as initially motivated, our main analysis in this article focuses on the post-crisis behavior of the cross-currency basis in response to the newly proposed macro drivers – inflation differential and relative economic performance. This is to ensure that our results capture the post crisis sample and are not driven by the GFC and its associated events that might influence the outcomes of our study. However, as cross-currency basis swap spreads became most profound during the GFC and persisted subsequently, we extend, as an additional robustness test, our analysis to cover samples from an earlier start date of August 2007 to capture the emergence of the widespread basis across currencies. The results, which also control for changes in the Libor-OIS spreads and the other covariates, are reported in Table below.

Table 2d: Additional regressions for 5-year and 3-month cross-currency basis (start date, August 2007)

	5-year basis		3-months basis	
	(1)	(2)	(1)	(2)
$\Delta(p_{kt}-p_{kt}^{us})$	-0.836***	-0.827**	-0.324	-0.323
	(0.317)	(0.323)	(0.474)	(0.483)
$\Delta\left(y_{kt}-y_{yt}^{us}\right)$	-0.102***	-0.102***	-0.034	-0.033
	(0.028)	(0.028)	(0.042)	(0.042)
$\Delta Dollar_t$	-0.868***	-0.867***	-0.486***	-0.485***
	(0.108)	(0.108)	(0.161)	(0.162)
$\Delta lnVIX_t$	-2.761***	-2.766***	-3.830***	-3.842***
	(0.854)	(0.857)	(1.278)	(1.283)
$\Delta Billateral_{kt}$	-0.180	-0.180	0.228	0.227
	(0.159)	(0.160)	(0.238)	(0.239)
$\Delta ImpliedVol_{kt}$	-0.405***	-0.404***	-0.414**	-0.412698**
	(0.133)	(0.133)	(0.199)	(0.199)
$\Delta 25DRR_{kt}$	-1.189***	-1.187***	-0.981*	-0.979*
	(0.353)	(0.355)	(0.529)	(0.531)
$\Delta YieldSpread_{kt}$	1.180	1.243	4.306**	4.378***
	(1.116)	(1.126)	(1.671)	(1.685)
$\Delta(TS_{kt}-TS^{us})$	-3.344***	-3.393***	-4.416***	-4.469***
	(0.972)	(0.979)	(1.454)	(1.466)
$\Delta LOIS_{kt}$	0.007	0.007	-0.033***	-0.033***
	(0.007)	(0.007)	(0.011)	(0.011)
Observations	1089	1089	1089	1089
R^2	0.179	0.179	0.082	0.082
Fixed effects included?	No	Yes	No	Yes

Note *, **, *** 10%, 5% and 1% significance respectively while standard errors in parenthesis are robust. Currency fixed effects are excluded. This table shows regression results of monthly changes in the 5-year and 3-month Libor cross currency basis on changes in log CPI differential $\Delta(p_{kt}-p_{ktUS})$ (that is, inflation differential) and changes in PMI differential $\Delta(y_{kt}-y_{tUS})$, (relative economic performance) and other controls. The dependent variables are the monthly changes in the 5-year and 3-month Libor cross-currency basis. The regressors of interest are the inflation differential $\Delta(p_{kt}-p_{ktUS})$ and relative economic performance $\Delta(y_{kt}-y_{tUS})$. The other independent variables (controls) are: $\Delta Dollar_t$, monthly change in the federal reserve board (FRB) trade-weighted broad dollar index, where $\Delta Dollar_t$>0 implies broad dollar appreciation ; $\Delta Bilateral_{kt}$, monthly change in the bilateral spot exchange rate of the local currency per dollar so that $\Delta Bilateral_{kt}>0$ implies appreciation of the dollar against the local currency; $\Delta lnVIX_t$, monthly change in the log of volatility index (VIX), $\Delta ImpliedVol_{kt}$ change in the log of implied volatility on 3-month at-the-money currency options; $\Delta 25DRR_{kt}$, monthly change in the 25-delta risk reversal; $\Delta YieldSpread_{kt}$ is the monthly change in yield spread; $\Delta(TS_{kt}-TS_{US})$ is the change in the term spread (TS), that is, the change in the difference between the foreign and US Treasury term spreads (10-year over 2-year) and $\Delta LOIS_{kt}$ is the change in Libor-OIS spread.

Again, overall, our main findings are robust and little-changed. The results in Table 2d show that previous findings are largely unaltered even after extending our sample to cover the GFC period and controlling for a host of variables which previous studies have found to have a notable impact on the cross-currency basis market. The results also provide evidence that our main findings are not altered by the GFC, otherwise the outcomes with and without including the GFC would have been completely different. In sum, we find that when inflation differential rises, i.e. when inflation increases in country i relative to the US, the cross-currency basis widens, i.e. becomes more negative. Wider basis gives rise to larger arbitrage opportunities of borrowing dollars cheaply in the cash market and lending dollars more profitably in the swap market, with currency risk exposure appropriately hedged. The higher the sensitivity of the basis to inflation differential, the wider or more negative it becomes following an increase in inflation differential, and the greater the arbitrage profit opportunities.

Meanwhile, as presented in Appendix (Table A2), the coefficient of inflation differential over the isolated GFC sample period is positive, which is opposite to that presented above. There are several reasons for this. First, notice that the connection between inflation differential and changes in cross-currency basis appears positive over the GFC period when other covariates are not kept constant given that we do not controlled for these variables. Since they are not included in that regression, this implies they may vary in ways that conceal the original association between inflation differential and the basis if other factors were kept constant. Take for instance, it is well known that the GFC period coincides with the time when major central banks like the US Federal Reserve Bank provided large dollar swap lines to expand dollar supply, ease dollar shortages, improve dollar liquidity and strengthen the global banking system. This action, which could count as a positive dollar liquidity shock to the global banking system, might potentially have influenced the behavior of the basis across major currencies, especially when relevant variables are not properly controlled for in the regression specification, causing the basis to respond positively with a rise in inflation differential. However, the basis associates negatively with inflation differential outside the GFC period window, when such sudden acceleration in dollar liquidity splurge eased relatively or normalized. More importantly, it is interesting to note that after controlling for other relevant variables, including the Libor-OIS spread which is a gauge for dollar funding liquidity stress in the financial market, the negative relation between inflation differential and changes in the basis becomes largely dominant.

5. Discussion of Results

Table 2a displays our regression results for the monthly changes in the five-year and three-month cross-currency basis. We first estimate the baseline regressions involving the two regressors of interest which are inflation differential and relative economic performance. Then we increase the number of regressors each time by gradually including other control variables that have been identified in the literature as potential drivers of CIP deviations in the post crisis period. Table 2a shows the results of the estimated baseline regressions (Column 1) as well as the results of the robustness checks (Columns 3 to 8) where we also control for other important and previously identified drivers of CIP deviations. Table 2b displays results of further robustness checks where we include currency fixed effects. In all the regressions, the coefficient estimates on inflation differential and relative economic performance are consistently negative and significant across the 8 specifications we considered, even including the specifications with the broad dollar index as a control variable. These results suggest that higher inflation differential and greater economic performance, at least in the near term, are each associated with more negative cross-currency basis, and, by extension, larger CIP deviations. The robust and significantly negative relations between changes in cross-currency basis and the above-mentioned drivers are true for both the 5-year basis, representing longer-term cross-currency basis, and 3-month basis which represents short-dated hedging contracts.

In terms of the magnitude, for the 5-year basis, the estimated coefficients on inflation differential and relative economic performance in Column 1, which excludes the control variables, implies that a one unit increase in inflation differential and in relative economic performance, in the foreign country viz-a-viz the US, is associated with more than and less than one basis point widening of the cross-currency basis, respectively, which implies wider CIP deviations. After including the dollar as a control variable in the specification as shown in Column 2, the previous results remain unaltered; that is, an increase in inflation differential and relative economic performance continues to induce wider cross-currency basis. Finally, we include all the control variables as shown in Column 8 and find that the narrative remains the same – our previous results is robust and significant. Hence, a rise in inflation differential and relative economic performance is associated with wider cross-currency basis and, hence, elevated CIP deviations.

For the 3-month basis, the magnitude of the estimated coefficients when the controls are excluded shows that a rise in inflation differential and relative economic performance widens the cross-currency basis by more than and less than one basis point respectively. When we include the dollar as a control, the results remain largely unchanged; we continue to see that even in the presence of the dollar, the identified variables bear a negative and significant relationship with the cross-currency basis. However, by the time all controls have been included, as shown in Column 8, we see that the effect of inflation differential remains robust and significant while relative economic performance, though retains its negative relationship with the three-month basis, loses its significance. Consequently, across terms of the basis considered, our results suggest that the effects of inflation differential are more robust than relative economic performance. Also, not only is the impact of inflation differential on the basis more robust, it is equally more statistically significant and economically meaningful. These results are particularly interesting in light of the observation that readings of monthly inflation differential tend to be especially noisy and hence more volatile as they are more prone to and affected by one-time events. Further robustness checks, where we vary the sampling frequency, can be found in Appendix A2 to A3.

Meanwhile, comparing the coefficients on our main regressors of interest, we see that the coefficients on inflation differential and relative economic performance for the 5-year basis are around 1.11 and 1.56 times greater than the corresponding coefficients for the 3-month basis. This suggests that when inflation differential and relative economic performance widen the basis, the effect is slightly higher in the longer end of the basis than for short-dated contracts. The significantly negative between changes in the cross-currency basis and proposed drivers is not restricted to regressions without currency fixed effects. In Table 2b, we perform further robustness checks and obtain similar results for regression specifications that include currency fixed effects. In sum, our main results are unchanged whether or not currency fixed effects are included in the regressions. In terms of the controls, and in all specifications, we confirm the negative association between the broad dollar index and the cross-currency basis. This confirms the influential role of the broad dollar index as a significant global driver of variations in cross-currency basis spreads whenever the broad dollar index is included in the regression. We also note that in all the specification, including the dollar also does not change our main results of the negative relationship between our proposed drivers and the cross-currency basis.

In terms of the other control variables, our results reveal that the estimated coefficients on changes in VIX are significant and robust across all specifications, irrespective of which control is included. The magnitude of the estimated coefficients suggests that changes in VIX can have quantitatively large and significant effects on the cross-currency basis across maturities. If global risk sentiment worsens, as evidenced by a positive change in the VIX, the cross-currency basis tends to become more negative, implying wider CIP deviations. Meanwhile, changes in the implied volatility of currency options enter all regressions negatively, more so for the 5-year cross-currency basis. They are negatively associated with changes in the cross-currency basis. One possible explanation for this negative relation is that higher currency volatility in a given foreign currency elevates the degree of riskiness of that currency and the corresponding balance sheets that are denominated in the currency. This reduces the risk-taking appetite of dollar-based financial intermediaries which in turn reduces the supply of dollar hedging activity, thereby leading to wider cross-currency basis. In addition, changes in FX option delta risk reversal, which measures the skewness of market expectations on future variations in currency value, are also negatively related with changes in the cross-currency basis.

Czech (2017) notes that when FX option delta risk reversal is large and positive (negative), this implies that higher probabilities are attached to large appreciation (depreciation) of the base currency, in this case the dollar. An increase (decrease) in the risk reversal, therefore, would suggest that market perception is skewed towards dollar appreciation (depreciation). The negative relation between changes in FX option delta risk reversal and changes in the cross-currency basis thus suggests that a distribution skewed in the direction of dollar appreciation (or foreign currency depreciation), contributes to wider CIP deviations. Lastly, where significant, the yield spread correlates positively with the basis, while the term spread differential, which is the difference in the slope of the treasury yield curves between foreign countries and the US, enters negatively in the regression. In separate regressions, reported in the Appendix (A3i and A3ii), we repeat our analysis using a lower frequency (quarterly) which makes it feasible to include data on Australia and New Zealand. Once again, we obtain negative coefficient estimates on inflation differential and relative economic performance, providing further evidence that our main results are robust and remain intact across all specifications, especially for the 5-year basis. In brief, we find that when relative economic performance improves and inflation differential rises, the cross-currency basis becomes more negative. This is much more so for inflation differential. In the baseline regression, relative economic performance and inflation differential both exhibit a similar effect, of different magnitudes, on the basis. They tend to result in wider cross-currency basis. After controlling for the other drivers, we discover that our main result still holds and are even robust to the inclusion of the broad dollar index and global risk sentiment. More so, we continue to find a negative effect of an increase in the dollar strength and a rise in the global risk sentiment on the cross-currency basis.

Finally, we provide comments on some possible ways that variations in these variables could potentially drive changes in CIP deviations. First, a rise in inflation differential between country k and the US induces depreciation of currency *k,* which puts an upward pressure on dollar strength. As Avdjiev et al. (2019) note, higher dollar strength then leads to wider cross-currency basis across. Thus, a rise in inflation differential leads to wider basis if the currency depreciation, and, hence, dollar appreciation, that accompanies a higher inflation differential dominates in the transmission mechanism. We note that apart from the robustness and significance of results, the additional explanatory power is in general low.

However, very importantly, it should be noted that the transmission mechanisms as described are not fully in line with the estimation results. We note that the scale and statistical significance of the negative relation between inflation differential and the basis, and between relative economic performance and the basis, especially at the 5-year maturity, are largely unaffected with the inclusion of the broad dollar index and bilateral exchange rates in the regressions. This points to the existence of stronger transmission mechanisms, other than dollar appreciation, as responsible for the obtained relationship. One plausible transmission mechanism through which higher inflation differential could widen cross-currency basis swap spreads and worsen CIP deviations could be via an increase in demand for dollar-denominated fixed income assets (hedged into the benchmark rates of the non-dollar currencies). This is the dollar-asset demand channel.

To understand this channel, first recall that fixed income investors receive stable nominal coupon payments[4], so a rise in inflation differential (that is, inflation in, say, country A relative to US inflation) potentially harms fixed income returns in currency A as purchasing power declines with rising inflation given fixed nominal payments. To combat this scenario, one way is for investors to increase demand for dollar-denominated fixed income assets hedged into currency A[5]. This demand for dollar-denominated fixed income assets increases the cost of synthetic

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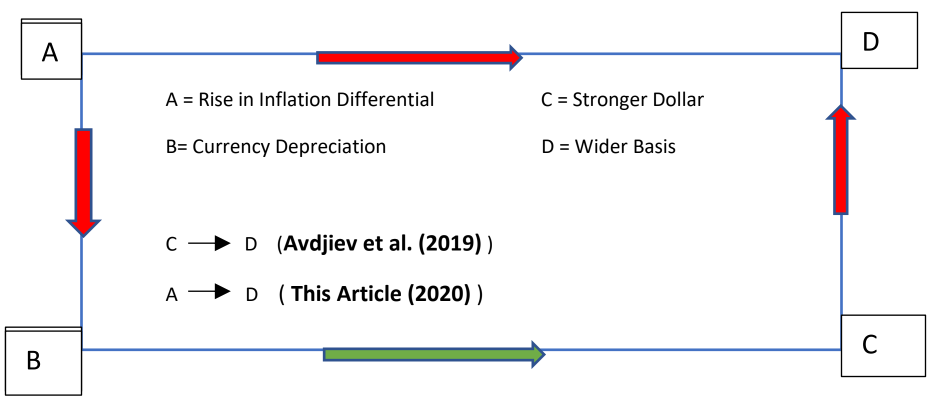
[4] In the absence of interest rate swaps which investors exchange these fixed payments for some floating variable payments.

[5] This potentially could offer higher inflation-adjusted returns than those obtained from investing in currency A-denominated bonds

dollars, i.e. offshore dollar cost, which then widens the cross-currency basis and expands deviations from CIP. In brief, the mechanism is such that higher inflation differential between country A relative to the US partly drives demand for dollar-denominated fixed income assets, raises demand for dollar funding and hedging activities, and widens the cross-currency basis. This channel takes the view that wider CIP deviations is a result of investors' desire to avoid the ills of rising inflation, i.e. erosion of real returns or invested capital, by holding dollar-denominated fixed income assets (hedged into local currency).

In summary, the mechanism described above, that works through the dollar, though plausible, does not appear dominant given that the effect of inflation differential on the basis remains unchanged and highly significant even after controlling for the dollar. This means that even without any changes in the broad dollar exchange rate, inflation differential still retains its effect on the basis, suggesting the possibility of a standalone, direct impact of inflation differential on changes in the basis. While we do not claim that a direct, unaided impact of inflation differential on the basis has been firmly established, we also do not claim to have uncovered the specific variables or mechanisms through which inflation differential influences the basis. In short, we do not discount the possibility that inflation differential may be working through other more plausible mechanisms or variables or, we just have not conclusively identified what they are in this paper.

Fig 2: Inflation Differential and Cross-currency Basis – A PossibleTransmission Mechanism



Note: Avdjiev et al. (2019) show that stronger dollar leads to wider basis (C to D). This paper shows that higher inflation differential also widens the basis (A to D).

The mechanism for the link between relative economic performance and cross-currency basis is more nuanced. Economic performance is a gauge for perceived systemic risk in an economy. This means that poor economic conditions could indicate heightened uncertainty, thus signifying risks for economic agents, corporate financial performance and, by extension, the broader financial market. To the extent that credit spreads turn on economic performance, weaker economic performance should therefore widen credit spreads. Chen (2010) finds that credit spreads widen in response to poor economic performance. Accordingly, we would expect better economic performance to lower credit spreads, implying lower borrowing costs. To the extent that lower borrowing costs attract nondollar issuance or borrowing by agents whose final currency of choice is the US dollar (i.e. those agents for whom US dollar is funded via cross-currency swaps using nondollar currencies, e.g. Japanese yen or euro, as a funding currency), demand for dollar hedges would rise, leading to a wider basis[6]. This interplay is highlighted in Arai et al. (2016) who show how the activities of nondollar agents who fund their dollar positions via currency swaps exert a widening pressure on the basis. They also document how lower credit spreads in a given currency triggers both dollar and nondollar agents, especially corporates, to fund their dollar demand via cross-currency swaps by first issuing cheaply in low credit spreads currencies and swapping proceeds to US dollars, which raises demand for US dollars in the swap market and widens the basis. Borio et al. (2018), in a recent study, also provides an exposition into how elevated hedging demand in currency swap markets via foreign currency issuance have contributed to wider basis. Thus, a positive change in relative economic performance can lead to wider cross-currency basis if demand for dollar hedges dominates in the transmission mechanism.

Another plausible way to partly view this relationship is through the interaction between lower funding costs and relative funding conditions, particularly the relative funding liquidity risk premium channel recently documented in Kohler and Muller (2018) and previously motivated in Wong et al. (2016). To build intuition, let us first define relative funding liquidity risk premium. According to Kohler and Muller (2018), relative funding liquidity risk premium expresses the preference of holding one currency (foreign currency), or collateral denominated in that currency, over another currency (US dollar). When this preference is high, agents (US dollar-based agents) demand a low premium to hold the foreign currency. Consequently, relative funding liquidity risk premium drops. This scenario played out during the GFC when non-US banks could access US dollars against their non-US dollar denominated collateral using the central bank US dollar swap line via their home central banks. On the other hand, when the preference is low, US dollar-based agents would demand a high premium to hold that foreign currency or accept collateral denominated in it. In this case, relative funding liquidity risk premium rises. This could happen, for instance, if foreign financial institutions have limited ability to access a US dollar facility against non-US dollar denominated collateral.

Intuitively, lower borrowing costs in foreign currencies, which raise currencies' relative abundance or trigger significant capital outflows, are a potential risk factor that could lower US dollar-based investors' preference for the foreign currencies, leading them to demand a high relative funding liquidity risk premium to hold these currencies. And as Kohler and Muller (2018) note, the presence of a positive and persistent relative funding liquidity risk premium, which signals market's preference for holding US dollars over most other currencies, then leads to significant departure from CIP, manifesting as cross-currency basis widening vis-`a-vis the US dollar.

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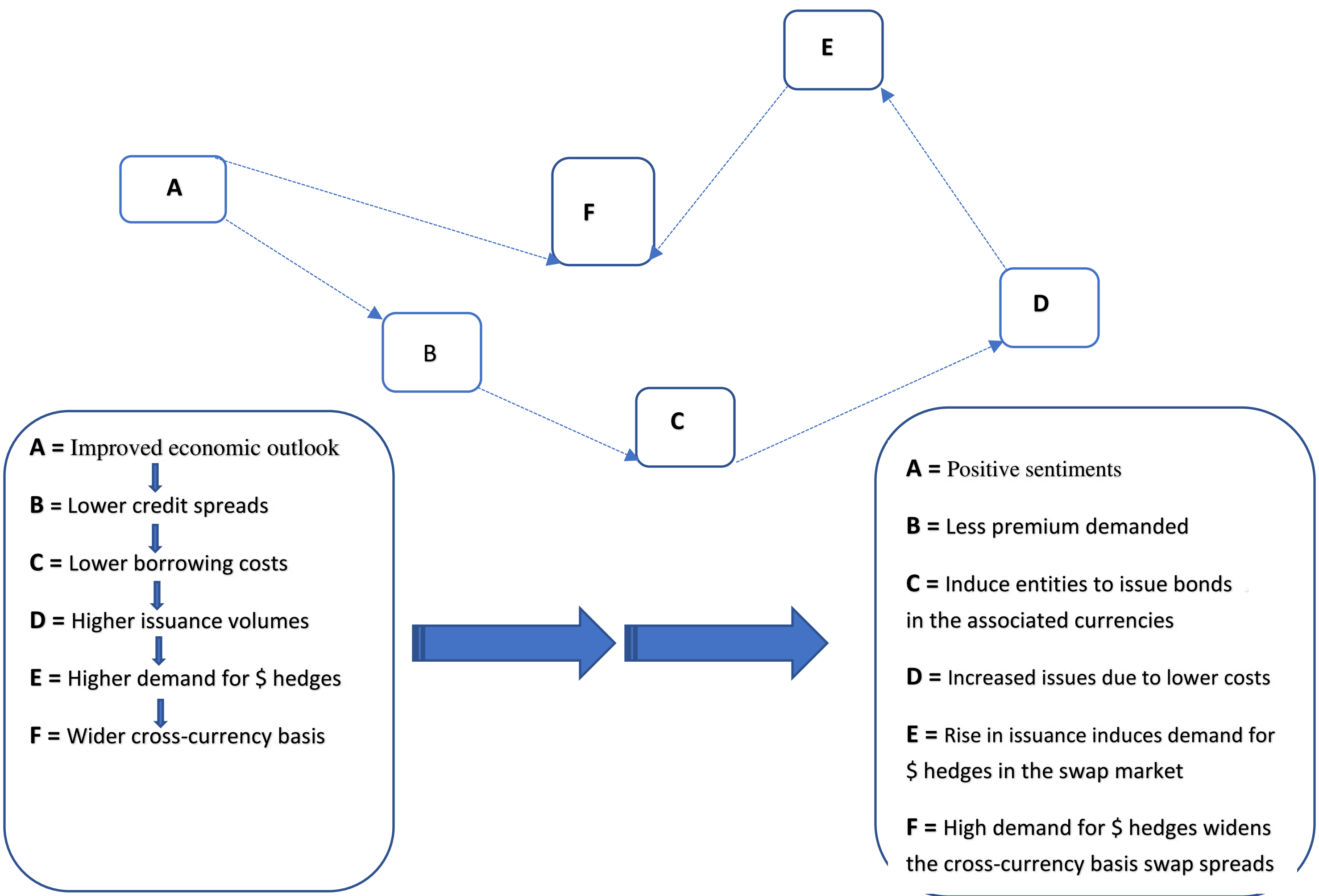
[6] Often, when there are indications of better economic performance, credit spreads tend to tighten as improved economic confidence reduces uncertainty, increases business confidence and improves general perception of risk. The lower spreads induce issuance in these currencies as lower spreads imply lower funding costs, consequently leading to a higher hedging demand for dollar swaps and a wider basis. In general, higher issuance in a nondollar currency can generate positive shocks to demand for hedging activity that leads to higher demand for dollar hedges and, through that, a wider cross-currency basis which worsens CIP deviations.

Fig 3: Relative Economic Performance and Cross-currency Basis – Transmission Mechanism



6. Inflation differential beta and the magnitude of the basis across currencies

In the last section, we provided empirical evidence that inflation differential drives changes in the cross-currency basis. In addition to that, in this section, we further examine the cross-sectional relations between i) sensitivity of the basis to inflation differential (the so-called inflation beta) and ii) the magnitude of the basis. This is with a goal of determining whether different loadings on inflation differential, that is the inflation betas, can help to explain the magnitudes of the bases across currencies. To do this, we separately regress changes in the basis on inflation differential over time for each currency. We then collect the coefficients on the inflation differentials, which are the estimated factor loadings on inflation differentials, i.e. the inflation betas, for all currencies. Finally, we perform a cross-sectional regression where we regress the mean cross-currency bases for all currencies on their corresponding inflation betas. This gives the coefficient on the inflation beta in the cross-sectional regression. If the mean basis regressed on the inflation beta yields a positive and significant coefficient on the inflation beta, then there is evidence that inflation differential is a priced risk factor for the basis and can help to significantly explain the magnitude of the basis in the cross-section. In other words, they can explain the differences in the basis seen across countries.

More formally, following the same methodology as in Avdjiev et al. (2019), let μ_k be the loading on the inflation differential for currency k, where μ_k is understood as the sensitivity of currency k's basis to inflation differential. When μ_k increases, this indicates that currency k's basis has become more sensitive to inflation differential. Let mb_k be the average value of the cross-currency basis for currency k, where, for each k, mb_k is the average taken over the sample period. If differing responses of the basis to inflation differential, i.e. μ_k, is the reason for the differences observed in the magnitudes or average values of the bases across currencies, then we would expect μ_k to have a positive and significant effect on mb_k. That is, a cross-sectional regression of mb_k on μ_k should yield a positive and statistically significant coefficient on μ_k. In such case, we would say that inflation differential acts as a potential risk factor which is priced into market participants' (dollar agents) decisions and leads them to demand a premium, i.e. higher arbitrage profit, equivalent to the widest or most negative basis they can possibly get, to incentivize them enough to take up arbitrage positions (i.e. pay the basis) and get compensated for exposure to the inflation risk factor. That is, the sensitivity of the basis to inflation differential partly determines how much arbitrage profit a basis arbitrageur would expect or be willing to realize from an arbitrage trade. The higher the sensitivity, the higher the arbitrage profit that would be demanded or expected as compensation for exposure to the risk factor. Thus, a basis that is highly sensitive to inflation differential would normally be expected to provide the most premium or arbitrage profit.

The results of cross-sectionally regressing the average cross-currency basis of each currency on the corresponding inflation beta are displayed in Table 3 below.

Table 3: Cross-sectional relationship between inflation beta and average basis across currencies

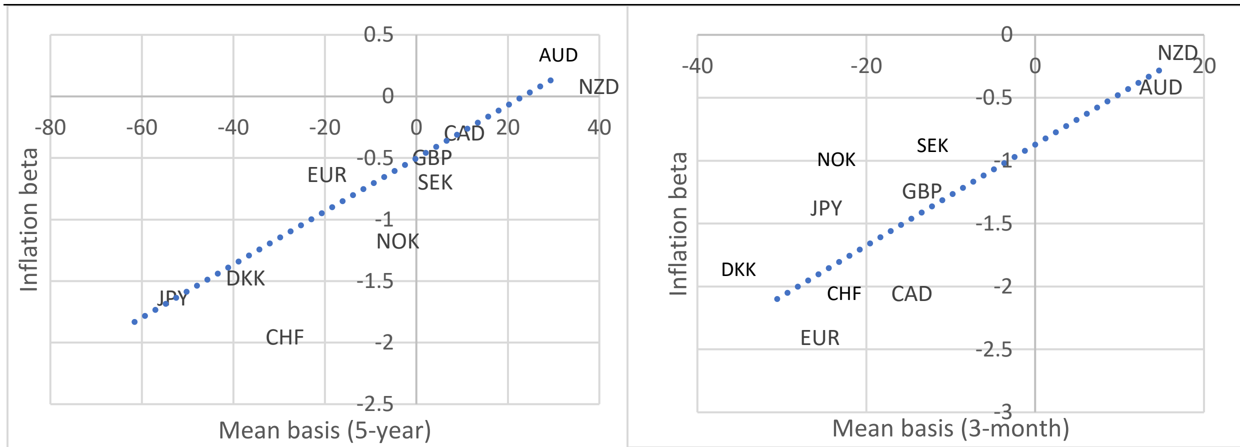
	Mean 5-year Basis	**Mean 3-month Basis**
Inflation Beta	37.398***	20.107***
	(6.490)	(4.282)
R^2	0.805	0.812

***, **, * is significance at 1%, 5% & 10%. Standard error in parenthesis. Inflation beta is the coefficient on the inflation beta. It is estimated by regressing the average (mean) basis on the inflation beta. The inflation beta is the estimated coefficient from regressing monthly changes in the basis on inflation differential at a monthly frequency for each country. For each country, average basis is computed as the average between January 2010 to December 2018.
Source: Authors, 2020.

Table 3 reports the regression coefficients obtained from regressing the average basis on the inflation beta. The coefficients on the inflation beta are strongly significant both for the five-year basis and the three-month basis. A one-unit increase in the magnitude of inflation beta, which is associated with a wider cross-currency basis, would correspond to 37 and 28 basis points rise in the magnitude of the basis, on average, for the 5-year and 3-month basis which corresponds to expected returns of 37 basis points based on the five-year CIP deviations and 28 basis points based on the 3-month CIP deviations.

To provide a visual view of the cross-sectional relationship between inflation beta and mean cross-currency basis, Fig 4 shows a graph of the average basis, plotted on the horizontal axis (X-axis), and the associated inflation beta on the vertical axis (Y-axis). The graphs show a strong positive relationship between the average basis and the inflation beta with a correlation of 0.898 for the five-year basis and 0.901 for the three-month basis.

Fig 4: Cross-currency basis and inflation beta



Note: The vertical axis shows the inflation beta - which is the regression coefficient gotten by running monthly regression of changes in the cross-currency basis on the inflation differential. The horizonal axis shows the average cross-currency basis, expressed in basis points, where the average is taken between January 2010 and December 2018. Left graph is generated with the 5-year basis, while right graph is with the 3-month basis. The straight line is a linear regression line (line of best fit), and the correlation between the level of the basis and the inflation beta is 0.898 for the 5-year basis and 0.901 for the 3-month basis respectively.

In sum, our results propose that cross-currency basis spreads associated with countries experiencing higher inflation differential tend to command higher expected returns for CIP arbitrage positions. The arbitrage returns are potentially higher for the 5-year basis compared to the 3-month basis for the same unit increase in the magnitude of the inflation differential beta.

6.1 Out-of-sample Robustness Check of Inflation Differential as a Risk Factor

We have shown, in the preceding section, that inflation differential is a potential risk factor which is priced into economic agents' pricing kernel in the fixed income/currency derivatives markets. We also document that higher value of this risk factor, which corresponds to higher sensitivity of the basis to inflation differential, commands a higher risk premium in the form of higher expected arbitrage returns (i.e. taking positions when the basis is widest or most negative) demanded by economic agents as compensation for exposure to the risk factor. This documentation was evidenced by a positive coefficient on the inflation beta in a single cross-sectional regression involving inflation differential betas and the mean levels of the cross-currency bases across countries. The setup of the single cross-sectional regression involves regressing the mean levels of the bases on the factor loadings (i.e. the factor betas/inflation betas).

Whilst true that this single cross-sectional regression approach is instructive and has its place in the literature, it is important to note that testing for the significance of the factor loadings (i.e. estimated inflation-differential betas) in this manner has its drawback. One potential reason is that the factor loadings on which the mean levels of the bases are regressed are themselves estimated from the first-differenced bases, possibly introducing some cross-sectional bias. Moreover, inferences from such set up might be weakened by heteroskedastic and serial correlation issues, biasing the standard errors and test statistics. Fama-Macbeth (1973) method, which is widely employed in the empirical asset pricing literature, provides a way to limit these issues. Therefore, as an additional robustness check, we perform further scrutiny by using Fama-Macbeth (1973) method to rigorously examine whether inflation differential is a potential risk factor for the basis. This allows us to contribute to this article in this section in two additional ways. First, we employ the Fama-Macbeth (1973) procedure to re-examine our initial finding that inflation differential is a priced risk factor for the cross-currency basis. Second, and more interestingly, we implement this procedure in an out-of-sample framework where we use data samples outside of the original sample period used in the preceding analysis. To this end, we choose more recent data from February 2019 to January 2020 covering the subsequent 12 months after the end of the original sample period. The aim of this exercise is to further inspect how results holds true for fresh, neutral data that have not been included in previous analysis.

Below, we first briefly describe the Fama-Macbeth (1973) method and implementation before we display the results.

6.1.1 The Fama-Macbeth Method

Suppose there are $i = 1, 2, \ldots\ldots, n$ cross-currency bases, with each observed over $t = 1, 2, \ldots., T$ time periods, where the frequency of observations could, for example, be monthly, in which case $t = 1, 2, \ldots., T$ would be understood as $month\ 1$ up to $month\ T$. In each time period t, let the changes in each basis i be represented as $\Delta xccy_{it}$. Suppose further that there exists a risk factor f_{it} common to all countries but assumes different values in each country and varies with time over the $t = 1, 2, \ldots., T$ time periods. In our application, f_{it} represents the inflation differential associated with $\Delta xccy_{it}$ for each i, where $i = 1, 2, \ldots\ldots, n$

First, we set up and run n individual time series regressions where, for each $i = 1, 2, \ldots\ldots, n$, the time series regression is performed over the T time periods. We regress changes in each basis on the corresponding risk factor (i.e. the inflation differential) over the time period. Thus, we estimate one-by-one the following system of regressions

$$\begin{cases} \Delta xccy_{1t} = \varphi_1 + \beta_1 f_{1t} + \varepsilon_{1t} \\ \Delta xccy_{2t} = \varphi_2 + \beta_2 f_{2t} + \varepsilon_{2t} \\ \qquad \vdots \quad \vdots \\ \Delta xccy_{nt} = \varphi_n + \beta_n f_{nt} + \varepsilon_{nt} \end{cases} \tag{5}$$

This gives n estimated betas i.e. $(\beta_1, \beta_2, \ldots, \beta_n)$, each representing the inflation differential beta or factor loading associated with each basis i. It measures the sensitivity of changes in the basis to inflation differential for each basis. This is the first stage of the procedure, which essentially involves estimating the factor loadings, $(\beta_1, \beta_2, \ldots, \beta_n)$,.

In the second past regression, which is the heart of Fama-Macbeth (1973) method, we formulate and run T different cross-sectional regressions; that is, we run a cross-sectional regression for each time period $t = 1, 2, \ldots, T$. This T cross-sectional regressions involve regressing changes in all bases on their corresponding factor loadings, starting from the first time period $t = 1$ and repeating the same process up until the last time period $t = T$, where the factor loadings are unchanged over each of the T time periods for which the cross-sectional regressions are conducted. Thus, the following system of T cross-sectional regressions are estimated one after the other for each of the time period $t = 1, 2, \ldots, T$:

$$\begin{cases} \Delta xccy_{i1} = q_1 + \mu_1 \beta_i + \epsilon_{1t} \\ \Delta xccy_{i2} = q_2 + \mu_2 \beta_i + \epsilon_{2t} \\ \qquad \vdots \\ \Delta xccy_{iT} = q_n + \mu_T \beta_i + \epsilon_{nt} \end{cases} \tag{6}$$

where $\mu_{t,}$ $t = 1,2, \ldots, T$ are the coefficients on the factor loadings and are used to compute the metric that helps us to determine whether inflation differential is a priced risk factor for the basis. The metric is obtained by averaging $\widehat{\mu_t}$, the estimated values of μ_t, over time as follows

$$\widehat{\mu} = \frac{1}{T}\sum_{t=1}^{T} \widehat{\mu_t}$$

where μ_t are taken as independent and identically distributed and, as a result, we have

$$\sigma^2(\widehat{\mu}) = \frac{1}{T}\sigma^2(\widehat{\mu_t}), \text{where } \sigma^2(\widehat{\mu_t}) = \frac{1}{T}\sum_{t=1}^{T}(\widehat{\mu_t} - \widehat{\mu})^2 \text{ and } t = \frac{\widehat{\mu}}{\sigma(\widehat{\mu_t})/\sqrt{T}}$$

If $\widehat{\mu} > 0$ significantly, then inflation differential is a risk factor and larger factor exposure – which in our case corresponds to greater sensitivity of the basis to inflation differential – would attract a higher magnitude of arbitrage profit, which would also imply that inflation differential is a priced risk factor. One major advantage of the Fama-Mac Beth approach over, for instance, a single cross-sectional regression involving time-averaged dependent variables regressed on their corresponding factors is that the latter is often plagued with empirical issues and weakened by the occurrence of heteroskedastic and autocorrelated estimates, resulting in biased standard errors and t statistic.

Having briefly described the Fama-Macbeth method, we present in the next section the results of its second past regression which tests the coefficient of the factor beta to ascertain if there is an out-of-sample evidence that the averaged period-by-period factor beta coefficient over the entire time period T is different from zero, which would imply that inflation differential is a risk factor.

4.3 Fama and Macbeth Second Past Regression Results

Table 4 below displays results obtained by implementing the Fama and Macbeth method over the 12-month out-of-sample period (February 2019 through January 2020), where $\widehat{\mu}$ represents the average value of the estimated coefficients on inflation differential betas from the period-by-period cross-sectional regressions while $\bar{R}^2$ is average value of the R^2's from these regressions.

Table 4: Fama and Macbeth Regression Results

	$\widehat{\mu}$	$\sigma(\widehat{\mu}) = \sigma(\widehat{\mu_t})/\sqrt{T}$	*t-stat*	$\bar{R}^2$
5-year basis	0.33***	0.13	2.58	0.27
3-month basis	-0.07	0.05	1.28	0.08

$\widehat{\mu}$ represents the average of the monthly coefficient on the factor loadings from the cross-sectional regressions over the 12-month period from February 2019 to January 2020, with outliers removed, $\sigma(\widehat{\mu})$ is the standard error of $\widehat{\mu}$, and $\bar{R}^2$ is the average R^2 value that comes from each monthly cross-sectional regression that gives rise to the coefficient on inflation beta used to estimate $\widehat{\mu}$. The results are displayed mostly for both the five-year basis and the three-month basis.

Table 3 shows that the averaged value $\widehat{\mu}$ of the coefficients on the inflation betas is positive $\widehat{\mu} > 0$ and significant for the five-year basis but insignificant for the three-month basis. Moreover, the absolute size of the coefficient $\widehat{\mu}$ is several times higher for the 5-year basis than the 3-month basis. Thus, the identified factor, inflation differential, is a priced risk factor for the 5-year basis in our out of sample specification. The stronger out-of-sample connection between the average value of the coefficients on inflation betas, $\widehat{\mu}$, and the 5-year basis partly echoes the previous in-sample finding that arbitrage returns are potentially more significant for the 5-year basis compared to the 3-month basis for the same rise in the magnitude of the factor loadings. That is, the 5-year basis is more sensitive to inflation differential or its sensitivity to inflation differential is more stable.

Below, we also provide a visual view of how the coefficients on the factor loadings from the period-by-period cross-sectional regressions vary over the out-of-sample 12-month period.

Fig 5: Monthly Cross-sectional Regression Estimates of Coefficients on Factor Loadings and the Corresponding R^2

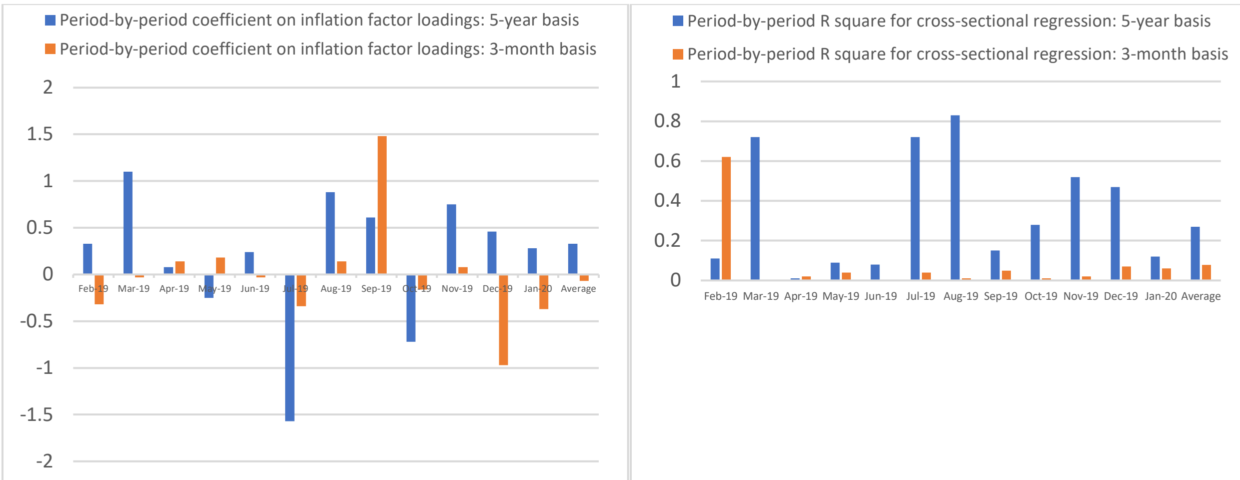


Fig. 5 displays the graphs of the coefficients on the inflation factor loadings for the 12-month period. We see that the coefficients are mostly positive for the 5-year basis than the 3-month basis, suggesting that, in the 12-month period, inflation differential is a more important risk factor for the 5-year basis than the 3-month basis.

In any case, where $\hat{\mu}$ is different from zero, we say that the proposed factor – inflation differential—is a risk factor and priced with a premium for the basis. This means that varying exposure or sensitivity to this risk factor explains some of the discrepancies in the magnitude of arbitrage profit across the dollar bases of different currencies. As such, economic agents would demand a high premium (i.e. larger arbitrage profit) when basis exposure or sensitivity to inflation differential is high. The phenomenon is particularly notable for the 5-year basis. In sum, with the Fama and Macbeth method, we are able to provide out-of-sample evidence that inflation differential can indeed be a risk factor for the basis. Thus, currencies whose dollar bases are highly sensitive to inflation differential command a higher premium via larger expected returns from CIP arbitrage positions, where the arbitrage returns are potentially higher for the 5-year basis than the 3-month basis for the same exposure to inflation differential.

7. Conclusion

Over the last decade, the foreign exchange derivatives market has witnessed an uninhibited collapse of covered interest parity (CIP), which has given rise to large CIP deviations and exploitable arbitrage opportunities across currencies. While there exists a growing literature on the nuances of CIP deviations across currencies and the links between market variables and cross-currency basis in the foreign exchange derivatives market, the literature on the drivers of the cross-currency basis – especially on the link between cross-currency basis, real economic performance and inflation dynamics – is still limited.

Understanding and untangling the drivers of the cross-currency basis, particularly the link between the basis and standard gauge of economic performance, is of key importance to policymakers and global foreign-exchange reserve managers at reserve banks, treasury departments and sovereign wealth funds for optimum currency management of diverse reserve assets and the management of large reserves liquidity profiles. This is to help managers reduce risk and be well-positioned to meet domestic and international financial stability obligations. More so, the issue is important for multilateral and international development institutions who seek to raise funds at the most favorable possible cost to support vulnerable economies and contribute to critical global stabilization efforts whilst working to promote economic prosperity through partnering with public and private sectors in developing market economies.

In this paper, we propose a novel relationship, particularly between inflation differential and the cross-currency basis. Our main finding is that higher inflation differentials tend to induce widening effects on the cross-currency basis. Our main results are remarkable as they are generally unaltered even after controlling for a large number of covariates, including the broad dollar index which previous studies have found to exert a strong effect on the basis. This paper is the first to empirically document a robust negative relationship between inflation differential and the cross-currency basis wherein when inflation differential goes up, cross-currency basis goes further down in the negative direction. Nonetheless, we note that apart from the robustness and significance of results, the additional explanatory power is in general low. We also find some evidence that if inflation differential is a risk factor, then a higher sensitivity of the basis to inflation differential, which means a rise in inflation differential triggers a more negative basis, should lead holders of the more special currency (dollar agents) to demand a higher premium, i.e. higher expected returns, which requires the basis to be more negative, before taking positions in a basis that is highly sensitive to inflation differential. That is, choosing to take positions when the basis is widest (most negative) in order to better position for the highest expected returns or arbitrage profit.

One direct implication of our result is that any fiscal and or monetary policy tool which reins in inflation and, hence, inflation differential is likely to also put a floor on the widening of the cross-currency basis and hence limit CIP deviations. Our result also suggests that supply side policies which improve economic performance and lower inflation, and hence inflation differential, are also likely to lessen CIP deviations. This is because, as we have found, inflation differential has a more dominant effect on the cross-currency basis than relative economic performance. In this case, a fall inflation, which leads to tighter cross-currency basis, dominates the rise in economic performance that leads to wider cross-currency basis, ultimately tightening the basis and lowering CIP deviations. An interesting empirical exercise for future research would be to perform country-specific analysis that examines the response of CIP deviations to the proposed factors in an effort to untangle further drivers of CIP deviations post crisis on a country-level basis.

8. Reference

Arai, T., Y. Makabe, Y. Ookawara, and T. Nagano. (2016). Recent Trends in Cross-Currency Basis. Bank of Japan Review No. 2016-E-7

Avdjiev, S., Du, W., Koch, C., and Shin, H. S. (2019). The Dollar, Bank leverage and the Deviation from Covered Interest Parity. American Economic Review: Insights, Forthcoming

Amano, R, and Ambler, S. (2014). Price-Level Targeting and the Zero Lower Bound (Technical Report). Bank of Canada and Université du Québec à Montréal.

Baba, N., and Packer, F. (2009). Interpreting Deviations from Covered Interest Parity during the Financial Market Turmoil of 2007–08. Journal of Banking and Finance 33 (11): 1953-62

Baran, J and Witzany, J. (2017). Analyzing Cross-Currency Basis Spreads. ESM Working Paper 25-2017, European Stability Mechanism, Luxembourg.

Boons, M., Duarte, F., de Roon, F., & Szymanowska, M. (2019). Time-varying inflation risk and stock returns. https://www.sciencedirect.com/science/article/pii/S0304405X19302429

Borio, C E.V., Iqbal, M., McCauley, R. N., McGuire, P.M., and Sushko, V., (2018). The Failure of Covered Interest Parity: FX Hedging Demand and Costly Balance Sheets. BIS Working Papers No. 590. Available at SSRN: https://ssrn.com/abstract=2910319 or http://dx.doi.org/10.2139/ssrn.2910319

Chen, H. (2010). Macroeconomic conditions and the puzzles of credit spreads and capital structure, Journal of Finance, 65(6), 2171–2212

Courcel, C, (2015, 2017). Cross-currency basis swaps: A primer Special focus on EUR/USD – Edition 1 & 2, BNP Paribas Strategy Desknote Europe, G10 Strategy.

Cheung, Y-W & Qian, X 2011. „Deviations from covered interest parity: The case of China." in „The Evolving Role of Asia in Global Finance." vol. 9, Frontiers of Economics and Globalization, vol. 9, Emerald Group Publishing Ltd., pp. 369-386.

Czech, K., (2017). Extracting Market Expectations from Currency Options' Risk Reversals. Annales Universitatis Mariae Curie-Skłodowska Lublin – Polonia Vol. Li, 6 Sectio H

Du, W, Tepper, A, & Verdelhan, A, (2018). Deviations from Covered Interest Parity, Journal of Finance, Vol. LXXIII, NO. 3

Engel, C., D. Lee, C. Liu, C. Liu, and S. P. Y. Wu (2018): The Uncovered Interest Parity Puzzle, Exchange Rate Forecasting, and Taylor Rules, Working Paper, University of Wisconsin.

Fama, E. F., & MacBeth, J. D. (1973). Risk, return, and equilibrium: Empirical tests. Journal of political economy, 81(3), 607-636.

Hui, C., H. Genberg and T. Chung (2010). Funding liquidity risk and deviations from interest-rate parity during the Financial crisis of 2007 – 2009. International Journal of Finance & Economics. n/a, doi: 10.1002/ijfe.427

Ibhagui, O., (2018). The Monetary Model of CIP Deviations, Working Paper, Munich Personal RePEc Archive

Ibhagui, O., (2019). Eurozone Real Output and Covered Interest Parity Deviations: Can Stronger Real Output Lessen the Deviations? Working Paper, Munich Personal RePEc Archive

Ibhagui, O., (2019). Wider Covered Interest Parity Deviations and Lower Stock Returns: Evidence from the Eurozone. Working Paper, Munich Personal RePEc Archive

Ivashina, V., D.S. Sharfstein, and J.C. Stein. 2015. Dollar Funding and the Lending Behavior of Global Banks Quarterly Journal of Economics 130 (3): 1241-81.

Kohler, D., and B. Muller (2018): Covered Interest Rate Parity, Relative Funding Liquidity and Cross-Currency Repos, typescript, Swiss National Bank.

Liao, G. (2016). Credit migration and covered interest rate parity. Working Paper.

Nakaso, H. (2017). Monetary Policy Divergence and Global Financial Stability. Speech by the Deputy Governor of the Bank of Japan at a meeting hosted by the International Bankers Association of Japan, Tokyo, January 20.

Pozsar, Z. 2016. Global Money Notes #8: From Exorbitant Privilege to Existential Trilemma. Credit Suisse

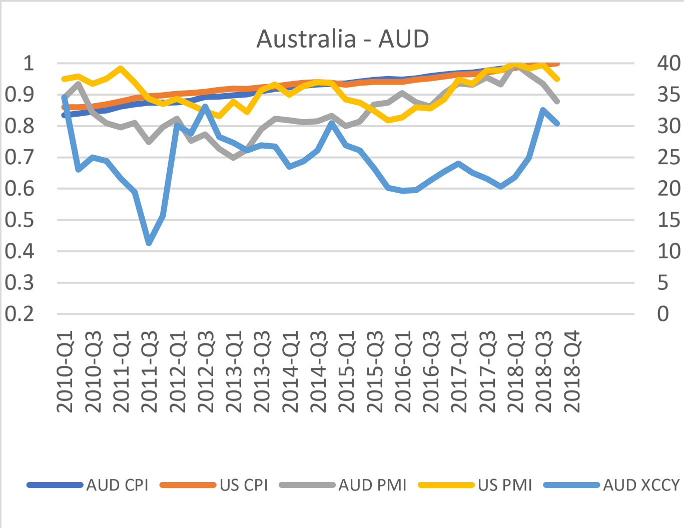
Rime, D., and Schrimpf, A., and Syrstad, O. (2019). Covered Interest Parity Arbitrage. BIS Working Paper Available at SSRN: https://ssrn.com/abstract=2879904 or http://dx.doi.org/10.2139/ssrn.2879904

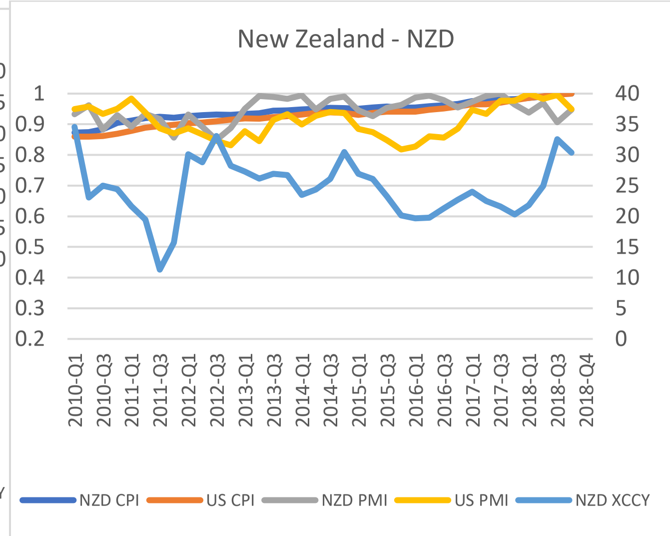
Wong, A., and J. Zhang (2018): Breakdown of Covered Interest Parity: Mystery or Myth?" typescript

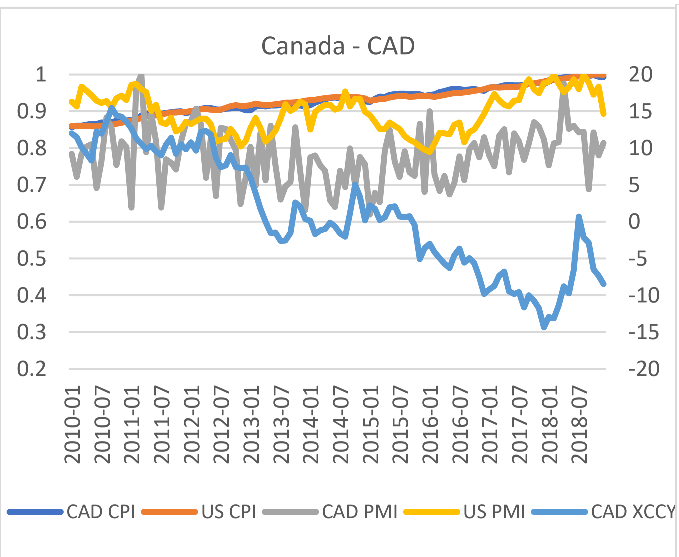
Wong, A., D. Leung, and C. Ng (2016): Risk-adjusted Covered Interest Parity: Theory and Evidence, Working Paper 16, HKIMR

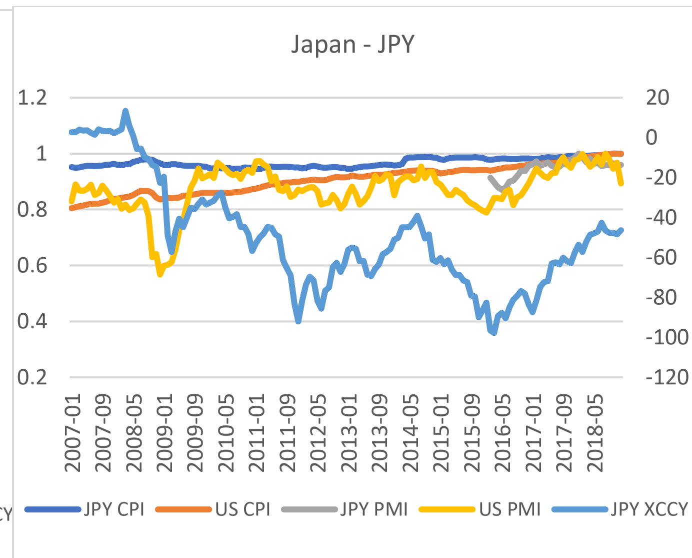
Appendix

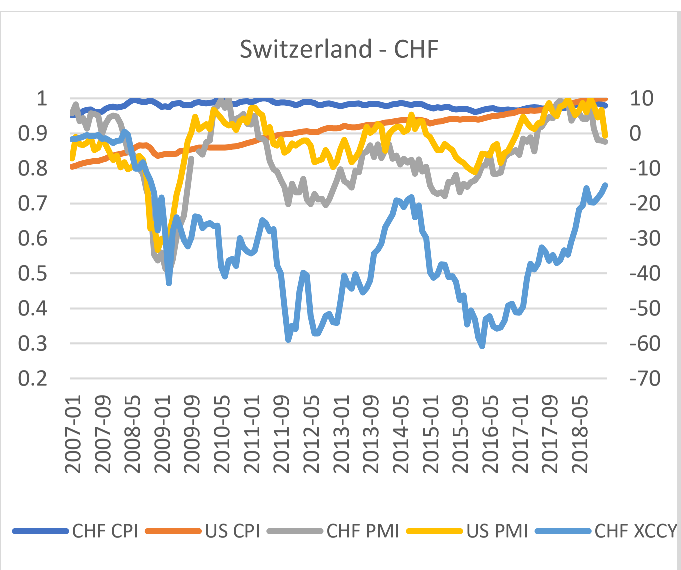
A1: Graphs of the cross-currency basis together with consumer price index and purchasing manager index

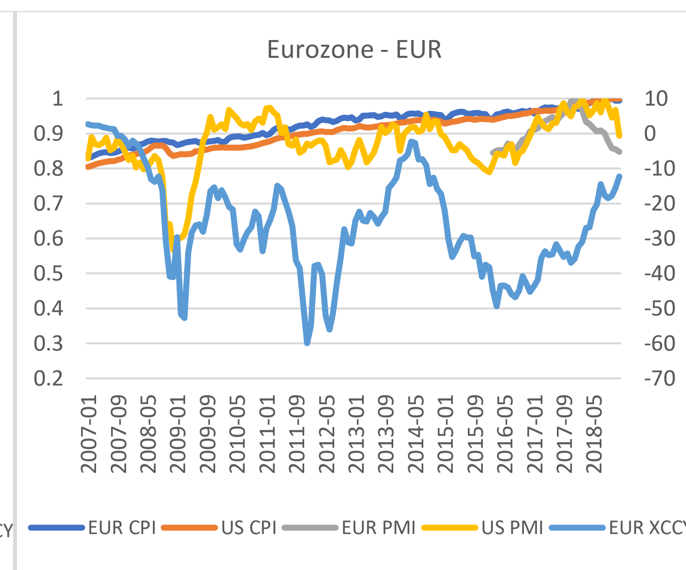

Australia - AUD
AUD CPI
US CPI
AUD PMI
US PMI
AUD XCCY

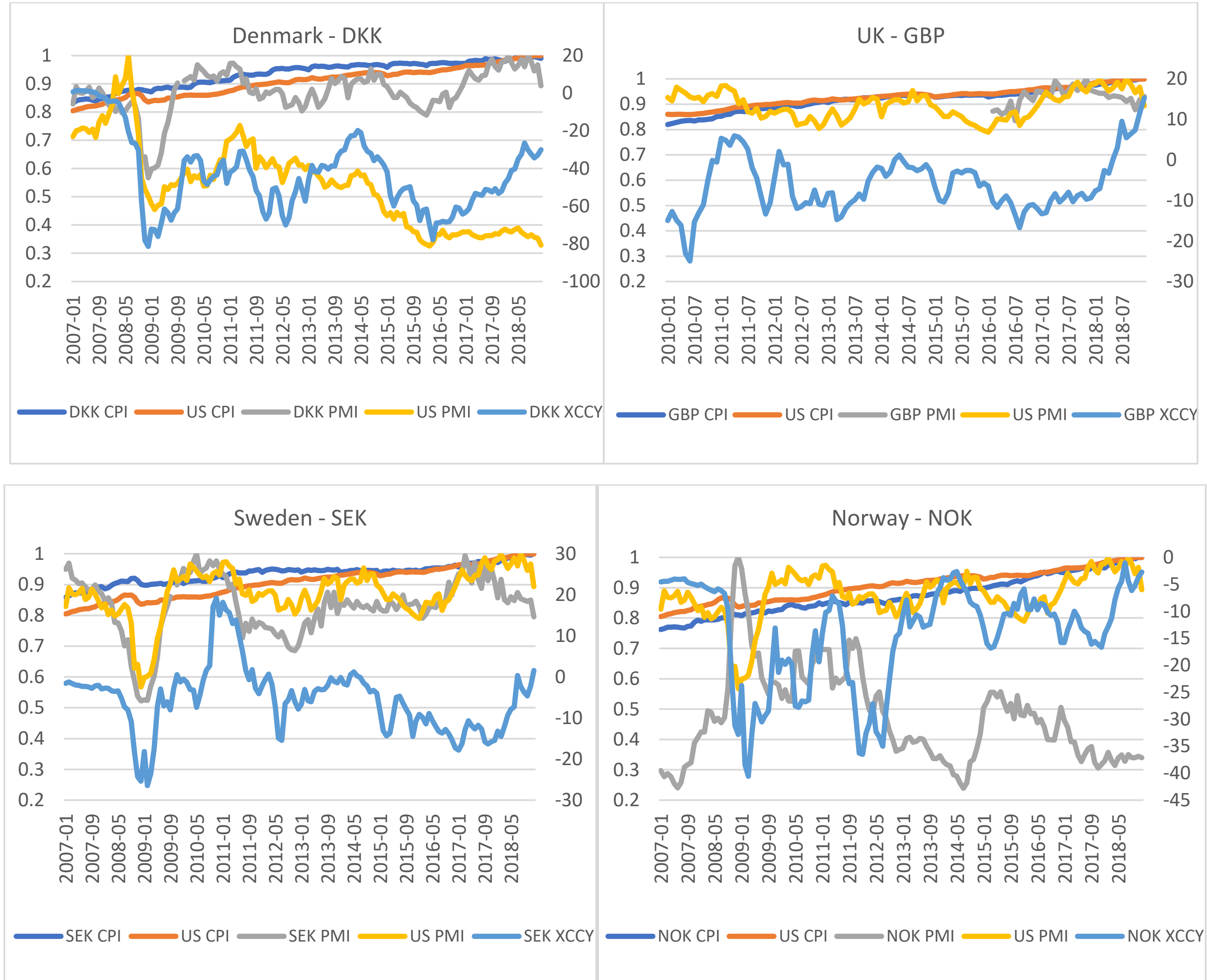

New Zealand - NZD
NZD CPI
US CPI
NZD PMI
US PMI
NZD XCCY


Canada - CAD
CAD CPI
US CPI
CAD PMI
US PMI
CAD XCCY


Japan - JPY
JPY CPI
US CPI
JPY PMI
US PMI
JPY XCCY


Switzerland - CHF
CHF CPI
US CPI
CHF PMI
US PMI
CHF XCCY


Eurozone - EUR
EUR CPI
US CPI
EUR PMI
US PMI
EUR XCCY



Note: The graphs above show plots of consumer price index, purchasing manager index and the cross-currency basis. Except for the cross-currency basis which is plotted on the right-hand side axis, all the other variables, plotted on the left-hand side axis, are scaled by their largest magnitude so that, on the new scale, the highest magnitude corresponds to the value of 1 while the others are below 1.

A2: Regression results of the drivers of cross-currency basis, by period

	Pre-Crisis (2002:M1 to 2006:M12)				GFC Crisis (2007:M1 to 2009:M12)				Post Crisis (2010:M1 to 2018:M12)				All (2002:M1 to 2018:M12)			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
$\Delta(p_{kt} - p_{kt}^{US})$	-0.0241	-0.0414	-0.0354	-0.0534	1.8501***	1.9197***	-0.5191	-0.4276	-1.1018***	-1.1053***	-1.0639***	-1.0710***	-0.0135	0.0041	-0.5506***	-0.5402***
	(0.0626)	(0.0627)	(0.0634)	(0.0636)	(0.7253)	(0.7403)	(0.8176)	(0.8395)	(0.3314)	(0.3366)	(0.3078)	(0.3127)	(0.2242)	(0.2267)	(0.2162)	(0.2188)
$\Delta(y_{kt} - y_t^{US})$	-0.0030	-0.0029	-0.0025	-0.0024	-0.2435***	-0.2448***	-0.1407*	-0.1432*	-0.1035***	-0.1039***	-0.0862***	-0.0866***	-0.1007***	-0.1005***	-0.0765***	-0.0763***
	(0.0068)	(0.0068)	(0.0069)	(0.0069)	(0.0880)	(0.0889)	(0.0846)	(0.0854)	(0.0277)	(0.0278)	(0.0255)	(0.0256)	(0.0218)	(0.0218)	(0.0205)	(0.0206)
$\Delta Dollar_t$			-0.0032	-0.0051			-1.0664***	-1.0506***			-0.6584***	-0.6561***			-0.5541***	-0.5535***
			(0.0208)	(0.0206)			(0.2399)	(0.2429)			(0.1092)	(0.1095)			(0.0672)	(0.0674)
$\Delta lnVIX_t$			-0.0570	-0.0450			-4.8158**	-4.7323**			-1.4941**	-1.4984**			-1.9082***	-1.9058***
			(0.2424)	(0.2407)			(2.3745)	(2.3972)			(0.7566)	(0.7591)			(0.6127)	(0.6140)
$\Delta Bilateral_{kt}$			-0.0797**	-0.0781**			-0.3727	-0.4796			-0.0103	-0.0056			-0.0997	-0.1003
			(0.0346)	(0.0343)			(0.3881)	(0.4063)			(0.1540)	(0.1553)			(0.1099)	(0.1101)
$\Delta ImpliedVol_{kt}$			0.0036	0.0001			-0.0615	-0.0738			-0.5968***	-0.5970***			-0.5623***	-0.5620***
			(0.0576)	(0.0572)			(0.2690)	(0.2720)			(0.1529)	(0.1534)			(0.1013)	(0.1015)
$\Delta 25DRR_{kt}$			-0.1877	-0.1758			-1.4852*	-1.3865*			-0.7079**	-0.7064**			-1.1685***	-1.1688***
			(0.1717)	(0.1706)			(0.8134)	(0.8265)			(0.3671)	(0.3683)			(0.2821)	(0.2826)
$\Delta YieldSpread_{kt}$			-0.1669	-0.1816			0.7509	0.7234			5.0208***	5.1198***			0.8812*	0.8811*
			(0.1695)	(0.1684)			(1.0503)	(1.0708)			(1.3184)	(1.3274)			(0.4896)	(0.4913)
$\Delta(TS_{kt} - TS^{US})$			-0.1419	-0.1716			-2.2233*	-2.2456*			-5.5388***	-5.6043***			-2.1248***	-2.1353***
			(0.2415)	(0.2405)			(1.2953)	(1.3162)			(1.2733)	(1.2802)			(0.5907)	(0.5924)
Observations	480	480	480	480	288	288	288	288	857	857	857	857	1625	1625	1625	1625
R^2	0.001	0.029	0.028	0.057	0.052	0.058	0.197	0.203	0.027	0.028	0.190	0.192	0.013	0.013	0.141	0.142
Fixed effects included	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes

Note: Standard error in parenthesis, *, **, *** 10%, 5% and 1% significance respectively. Dependent variable is 5-year cross-currency basis

A3i: Regression results of the 5-year and 3-month cross-currency basis (quarterly frequency)

5-year basis	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta(p_{kt} - p_{kt}^{US})$	-0.6268	-0.6528	-0.6708*	-0.6870*	-0.6417	-0.6810*	-0.6872*	-0.6941*
	(0.4307)	(0.4129)	(0.4034)	(0.4025)	(0.4049)	(0.4056)	(0.4050)	(0.4050)
$\Delta(y_{kt} - y_t^{US})$	-0.2817***	-0.2214**	-0.1819**	-0.1828**	-0.1933**	-0.2056**	-0.2097**	-0.2164**
	(0.0891)	(0.0862)	(0.0849)	(0.0847)	(0.0853)	(0.0857)	(0.0856)	(0.0859)
$\Delta Dollar_t$		-0.6637***	-0.6577***	-0.6013***	-0.5657***	-0.5502***	-0.6087***	-0.5764***
		(0.1321)	(0.129)	(0.1339)	(0.1382)	(0.1386)	(0.145)	(0.1483)
$\Delta lnVIX_t$			-4.5769***	-4.5495***	-3.7511***	-4.0148***	-4.0373***	-3.8372***
			(1.2156)	(1.2127)	(1.4385)	(1.4518)	(1.4497)	(1.4625)
$\Delta Bilateral_{kt}$				-0.6117	-0.6113	-0.5822	-0.634	-0.6391
				(0.3999)	(0.3999)	(0.4001)	(0.4013)	(0.4013)
$\Delta ImpliedVol_{kt}$					-0.2438	-0.2319	-0.2205	-0.1937
					(0.2362)	(0.2362)	(0.2359)	(0.2373)
$\Delta 25DRR_{kt}$						-0.6717	-0.6931	-0.712
						(0.5298)	(0.5293)	(0.5295)
$\Delta YieldSpread_{kt}$							-2.4858	-1.8052
							(1.8434)	(1.9576)
$\Delta(TS_{kt} - TS^{US})$								-1.8853
								(1.8268)
$Observations$	275	274	273	272	271	270	269	268
R^2	0.0408	0.1218	0.1651	0.1723	0.1755	0.1804	0.1859	0.1891
Fixed effects included?	No	No	No	No	No	No	No	No

3-month basis	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta(p_{kt} - p_{kt}^{US})$	-0.5732	-0.5801	-0.5836	-0.5678	-0.7042	-0.7320	-0.7418	-0.7334
	(0.4765)	(0.4762)	(0.4768)	(0.4765)	(0.4740)	(0.4758)	(0.4738)	(0.4737)
$\Delta(y_{kt} - y_t^{US})$	-0.1317	-0.1158	-0.1081	-0.1072	-0.0756	-0.0843	-0.0907	-0.0826
	(0.0985)	(0.0994)	(0.1003)	(0.1002)	(0.0998)	(0.1006)	(0.1002)	(0.1004)
$\Delta Dollar_t$		-0.1744	-0.1733	-0.2285	-0.3358**	-0.3249**	-0.4174**	-0.4565***
		(0.1523)	(0.1525)	(0.1585)	(0.1619)	(0.1626)	(0.1697)	(0.1735)
$\Delta lnVIX_t$			-0.8937	-0.9204	-3.3277**	-3.5138**	-3.5494**	-3.7921**
			(1.437)	(1.4355)	(1.6843)	(1.7032)	(1.696)	(1.7106)
$\Delta Bilateral_{kt}$				0.5982	0.5971	0.6176	0.5357	0.5419
				(0.4734)	(0.4682)	(0.4693)	(0.4695)	(0.4694)
$\Delta ImpliedVol_{kt}$					0.7349***	0.7433***	0.7613***	0.7288***
					(0.2766)	(0.277)	(0.276)	(0.2776)
$\Delta 25DRR_{kt}$						-0.4739	-0.5078	-0.4849
						(0.6216)	(0.6192)	(0.6194)
$\Delta YieldSpread_{kt}$							-3.9319*	-4.7572**
							(2.1566)	(2.2899)
$\Delta(TS_{kt} - TS^{US})$								2.2861
								(2.1368)
$Observations$	275	274	273	272	271	270	269	268
R^2	0.0111	0.0158	0.0172	0.0229	0.0477	0.0498	0.0614	0.0654
Fixed effects included?	No	No	No	No	No	No	No	No

Note *, **, *** 10%, 5% and 1% significance respectively. Currency fixed effects are excluded. This table shows regression results of monthly changes in the 5-year and 3-month Libor cross currency basis on changes in log CPI differential $\Delta(p_{kt} - p_{kt}^{US})$ (that is, inflation differential) and changes in PMI differential $\Delta(y_{kt} - y_t^{US})$, (relative economic performance) and other controls. The dependent variables are the monthly changes in the 5-year and 3-month Libor cross-currency basis. The regressors of interest are the inflation differential $\Delta(p_{kt} - p_{kt}^{US})$ and relative economic performance $\Delta(y_{kt} - y_t^{US})$. The other independent variables (controls) are: $\Delta Dollar_t$, monthly change in the federal reserve board (FRB) trade-weighted broad dollar index, where $\Delta Dollar_t$>0 implies broad dollar appreciation ; $\Delta Bilateral_{kt}$, monthly change in the bilateral spot exchange rate of the local currency per dollar so that $\Delta Bilateral_{kt} > 0$ implies appreciation of the dollar against the local currency; $\Delta lnVIX_t$, monthly change in the log of volatility index (VIX), $\Delta ImpliedVol_{kt}$ change in the log of implied volatility on 3-month at-the-money currency options; $\Delta 25DRR_{kt}$, monthly change in the 25-delta risk reversal; $\Delta YieldSpread_{kt}$ is the monthly change in yield spread; $\Delta(TS_{kt} - TS^{US})$ is the change in the term spread (TS), that is, the change in the difference between the foreign and US Treasury term spreads (10-year over 2-year). Standard errors in parenthesis are robust. Sources: Bloomberg; FRED, author's calculations

A3ii: Regression results of the 5-year and 3-month cross-currency basis, with c*urrency fixed effects included* (quarterly frequency):

			5-year basis					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta(p_{kt} - p_{kt}^{US})$	-0.7089	-0.7316*	-0.7497*	-0.7641*	-0.7105*	-0.7519*	-0.7561*	-0.7731*
	(0.4416)	(0.4240)	(0.4138)	(0.4129)	(0.4153)	(0.4160)	(0.4160)	(0.4156)
$\Delta(y_{kt} - y_t^{US})$	-0.2729***	-0.2156**	-0.1758**	-0.1767**	-0.1882**	-0.201**	-0.2043**	-0.2127**
	(0.0893)	(0.0866)	(0.0852)	(0.085)	(0.0855)	(0.0859)	(0.086)	(0.0861)
$\Delta Dollar_t$		-0.6435***	-0.6373***	-0.5815***	-0.5415***	-0.5255***	-0.5713***	-0.5277***
		(0.1327)	(0.1295)	(0.1344)	(0.1388)	(0.1391)	(0.1464)	(0.15)
$\Delta lnVIX_t$			-4.599***	-4.5719***	-3.6805**	-3.9511***	-3.97***	-3.7165**
			(1.2177)	(1.2149)	(1.4413)	(1.4543)	(1.4544)	(1.4655)
$\Delta Bilateral_{kt}$				-0.6048	-0.6045	-0.5739	-0.6133	-0.6178
				(0.4009)	(0.4006)	(0.4008)	(0.4027)	(0.4022)
$\Delta ImpliedVol_{kt}$					-0.2722	-0.2604	-0.2507	-0.2165
					(0.2372)	(0.237)	(0.2372)	(0.2384)
$\Delta 25DRR_{kt}$						-0.6923	-0.707	-0.7332
						(0.5313)	(0.5314)	(0.5311)
$\Delta YieldSpread_{kt}$							-1.8884	-0.9629
							(1.8753)	(2.0038)
$\Delta(TS_{kt} - TS^{US})$								-2.4081
								(1.8536)
Observations	266	265	264	263	262	261	260	259
R^2	0.0412	0.1193	0.1645	0.1716	0.1758	0.1811	0.1843	0.1896
Fixed effects included?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

				3-month basis				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta(p_{kt} - p_{kt}^{US})$	-0.6123	-0.6187	-0.6221	-0.6077	-0.7544	-0.7851	-0.7941	-0.7782
	(0.4940)	(0.4937)	(0.4944)	(0.4939)	(0.4915)	(0.4932)	(0.4911)	(0.4913)
$\Delta(y_{kt} - y_t^{US})$	-0.138	-0.122	-0.1143	-0.1134	-0.082	-0.0915	-0.0984	-0.0905
	(0.1)	(0.1008)	(0.1017)	(0.1016)	(0.1012)	(0.1019)	(0.1015)	(0.1018)
$\Delta Dollar_t$		-0.18	-0.1788	-0.2347	-0.3443**	-0.3325**	-0.43**	-0.471***
		(0.1545)	(0.1547)	(0.1607)	(0.1642)	(0.165)	(0.1728)	(0.1773)
$\Delta lnVIX_t$			-0.8825	-0.9096	-3.3493*	-3.5495**	-3.5897**	-3.8282**
			(1.4548)	(1.4533)	(1.7057)	(1.7244)	(1.717)	(1.7322)
$\Delta Bilateral_{kt}$				0.6057	0.6048	0.6274	0.5434	0.5476
				(0.4795)	(0.4741)	(0.4752)	(0.4754)	(0.4753)
$\Delta ImpliedVol_{kt}$					0.7451***	0.7538***	0.7744***	0.7421***
					(0.2807)	(0.2811)	(0.2801)	(0.2817)
$\Delta 25DRR_{kt}$						-0.5122	-0.5434	-0.5187
						(0.6299)	(0.6274)	(0.6278)
$\Delta YieldSpread_{kt}$							-4.0201*	-4.8907**
							(2.214)	(2.3684)
$\Delta(TS_{kt} - TS^{US})$								2.2651
								(2.1909)
Observations	266	265	264	263	262	261	260	259
R^2	0.0121	0.0172	0.0185	0.0245	0.05	0.0524	0.0643	0.0681
Fixed effects included?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note *, **, *** 10%, 5% and 1% significance respectively. Standard errors in parenthesis are robust. Currency fixed effects are included. This table shows regression results of monthly changes in the 5-year and 3-month Libor cross currency basis on changes in log CPI differential $\Delta(p_{kt} - p_{kt}^{US})$ (that is, inflation differential) and changes in PMI differential $\Delta(y_{kt} - y_t^{US})$, (relative economic performance) and other controls. The dependent variables are the monthly changes in the 5-year and 3-month Libor cross-currency basis. The regressors of interest are the inflation differential $\Delta(p_{kt} - p_{kt}^{US})$ and relative economic performance $\Delta(y_{kt} - y_t^{US})$. The other independent variables (controls) are: $\Delta Dollar_t$, monthly change in the federal reserve board (FRB) trade-weighted broad dollar index, where $\Delta Dollar_t$>0 implies broad dollar appreciation ; $\Delta Bilateral_{kt}$, monthly change in the bilateral spot exchange rate of the local currency per dollar so that $\Delta Bilateral_{kt} > 0$ implies appreciation of the dollar against the local currency; $\Delta lnVIX_t$, monthly change in the log of volatility index (VIX), $\Delta ImpliedVol_{kt}$ change in the log of implied volatility on 3-month at-the-money currency options; $\Delta 25DRR_{kt}$, monthly change in the 25-delta risk reversal; $\Delta YieldSpread_{kt}$ is the monthly change in yield spread; $\Delta(TS_{kt} - TS^{US})$ is the change in the term spread (TS), that is, the change in the difference between the foreign and US Treasury term spreads (10-year over 2-year). Standard errors in parenthesis are robust. Currency fixed effects are included in all specifications. Sources: Bloomberg; FRED, author's calculations