Cross-currency credit spreads: harvesting the idiosyncratic basis as a source of ARP

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Abstract
This paper identifies the "idiosyncratic basis", the residual premia computed from stripping away the hypothetical cross-currency basis (CCB) from the cross-currency credit spread (CCCS) of eligible senior corporate dollar-denominated bonds relative to their hypothetical euro-denominated comparator of identical seniority, duration, credit risk and issuer. The adherence of the idiosyncratic basis to the no-arbitrage condition is subsequently evaluated through the application of an indicative market-neutral credit strategy that is designed to harvest the apparent static arbitrage opportunities. The success of the strategy, which systematically captures the idiosyncratic basis as it adheres to the no-arbitrage conditions, is validated retrospectively to frame the basis as an additional class of alternative risk premia (ARP), which investors can seek to optimise exposure to in a long-only context.

Keywords Fixed income, Covered interest rate parity, Alternative risk premia, Static arbitrage
Paper type Research paper

1. Introduction
The covered interest [rate] parity (CIP) condition is a no-arbitrage condition, which determines nominal FX forward pricing under the premise that the destination of the future path of any given currency pair is an arithmetic function of the spot exchange rate and the expected interest rate differential between the foreign, FOR, and domestic, DOM, currencies over the path window. This condition is represented approximately by the equality:

$$\frac{F^{\mathrm{DOM/FOR}}}{S^{\mathrm{DOM/FOR}}} = \frac{\left(1 + i^{\mathrm{FOR}}\right)}{\left(1 + i^{\mathrm{DOM}}\right)} \tag{1}$$

Formula developed from Feenstra and Taylor (2008)

The equality can be rearranged to derive the implied yield of the foreign currency:

$$i^{\mathrm{FOR}} = \frac{F^{\mathrm{DOM/FOR}}}{S^{\mathrm{DOM/FOR}}}\left(1 + i^{\mathrm{DOM}}\right) - 1 \tag{2}$$

Similarly, the equality can be rearranged to derive the implied yield of the domestic currency:

$$i^{\mathrm{DOM}} = \frac{S^{\mathrm{DOM/FOR}} \cdot \left(1 + i^{\mathrm{FOR}}\right)}{F^{\mathrm{DOM/FOR}}} - 1 \tag{3}$$

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where i^{FOR} is the foreign interest rate on foreign deposits, $F^{\mathrm{DOM/FOR}}$ is the forward exchange rate DOM/FOR (direct quotation) for a given tenor at time 0, $S^{\mathrm{DOM/FOR}}$ is the spot rate DOM/FOR at time 0 and i^{DOM} is the domestic return on domestic deposits.

As such, it is implied that the foreign return on foreign deposits is equal to the foreign return on domestic deposits where the domestic return has been covered with a forward contract to hedge the FX risk; this can be related to the theory of uncovered interest [rate] parity (UIP), where the expected spot price, $\mathbb{E}^{\mathrm{FOR/DOM}}$, at some future time rather than the forward price ($F^{\mathrm{FOR/DOM}}$) at time 0 for a contract of tenor equivalent to the expectation date is a function of the foreign return on foreign deposits relative to the domestic return on domestic deposits. Per the "expectations theory" or forward rate unbiasedness hypothesis (FRUH), when both CIP and UIP synchronically hold over a given timespan, and thus $F^{\mathrm{FOR/DOM}} = \mathbb{E}^{\mathrm{FOR/DOM}}$, forward markets serve as an unbiased predictor of future spot rates. The FRUH has, however, been found to fail empirically (*inter alia*, Hodrick, 1987; Froot and Thaler, 1990; Lewis, 1995 and Engel, 1996), although some empirical explorations find consistency in interest rate parity when adjusting for practical frictions (*inter alia*, Frenkel and Levich, 1975).

Since the 2008 global financial crisis (GFC), the cross-currency basis (CCB) has consistently violated the CIP condition (Baba and Packer, 2009a, b; Baba *et al.*, 2008; Borio *et al.*, 2016; Du *et al.*, 2018; Mancini-Griffoli and Ranaldo, 2010) causing the terminology to become perceived as a misnomer; "basis" inherently assumes the existence of a [static] arbitrage opportunity, but the CCB has persistently failed to tend towards equilibrium and has resisted successful arbitrage; the no-arbitrage condition should have otherwise seen the basis anchored to zero over time [1]. This phenomenon has been a source of discourse for academics and policymakers in understanding and resolving potential limits to market efficiency and arbitrage, whether they emanate from legal or regulatory restrictions [2], unaccounted frictions and risks [3] or the inaction of market participants [4]. Fundamentally, the CCB is driven by demand and supply imbalances (Bottazzi *et al.*, 2012) and, failing to be anchored to zero, has subsequently become a standalone Over-the-Counter (OTC) product. A negative CCB, where, for example, a basis is due for a borrower seeking dollars, is indicative of a synthetic dollar interest rate in the FX market pricing higher than the direct dollar interest rate (Du and Schreger, 2021). Du and Schreger find that the basis is "highly correlated with nominal interest rates across currencies and [that the basis] co-moves with global risk factors". The trend of the EUR/USD basis across the standard tenors is presented in Figure 1.

In this study, IHS Markit OTC CCB data derived from EUR/USD (float/float) LIBOR-indexed swaps (commonly, "EUR/USD basis swaps") are referenced as a useful proxy for quantifying the shortfall in exchange currency availability relative to investor demand (Bottazzi *et al.*, 2012) [5], representing "the currency-hedged borrowing cost difference between currency regions" (Liao, 2019), or effectively the long-term valuation deviation between floating dollar LIBOR and floating EURIBOR (EUR LIBOR) from the CIP condition (Du and Schreger, 2021). The motivation of this study stems from the work of Du *et al.* (2018) and Liao (2019), which highlights the cross-sectional similarity in the deviations in CIP and fixed income spreads, such as the CCB.

Similarly, but separately, one would expect two otherwise mechanically and hierarchically identical corporate bonds to trade pari passu when priced in parallel currency markets such that their implied credit risk is identical in both markets. The cross-currency credit spread (CCCS), however, is susceptible to violation of the no-arbitrage condition in practice also. Observing the pricing in the aggregate of senior US dollar-denominated credit, investors should note the more-than-proportional tightening in credit spreads relative senior euro-denominated credit over the period of the COVID-19 crisis.

Building upon the anecdotal evidence observed in the market of a deviation in the pricing of credit risk, a study into the CCCS is introduced, seeking to quantify the premium of bonds in the iBoxx USD Corporates Senior Index relative to their respective hypothetical

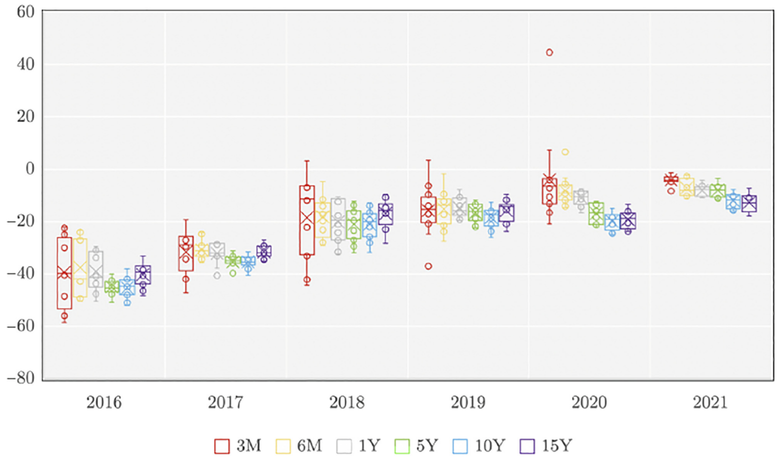


Figure 1.
Cross-currency basis standard tenor trend (bps) by year

Source(s): IHS Markit, Author

comparators in the iBoxx EUR Corporates Senior Index [6], derived using the matching method, for each monthly increment in the study window (31/01/2016–31/08/2021). We adopt the matching method in pursuit of evaluating the relative pricing of the hypothetical comparator from an issuer (in the latter, EUR, market), critically aligning to the duration of an observable bond from the same issuer (in the former, USD, market). In our study, this is achieved by interpolating for the hypothetical coparator across the issuer's EUR curve with respect to the duration of the observable reference bond, in the case where a bond of identical characteristics does not exist in both of the issuer's curve at any given evaluation date. The matching method allows us to establish a commensurate comparison of risky spreads, controlling for the limiting factors inherent in a non-flat term structure and ensure a comparable pricing analysis. Having established the existence of a premium, we adjust for the hypothetical CCB at each monthly increment in the study window to determine the "idiosyncratic basis", an umbrella term for the residual risk premia, which is not further disaggregated into component risk premia.

We conduct an analysis of the characteristics and behaviour of the idiosyncratic basis relative to the CCB and design a theoretical long-short static credit arbitrage strategy, which seeks to isolate the idiosyncratic basis. The strategy is validated retrospectively to assess the potential success of arbitrageurs in capitalising on the prevailing dislocations in the market's pricing of credit risk across currencies and the adherence of idiosyncratic basis to the no-arbitrage condition; conversely to the behaviour of the CCB, the study finds that the path of the residual premia consistently gravitates towards normality under the no-arbitrage condition (zero), presenting arbitrageurs with opportunities to profitably exploit some portion of credit risk mispricing.

2. Methodology

2.1 Determining the cross-currency credit spread

To conduct the study, we begin by defining and then deriving the CCCS, $\Psi_{i,t}$, for bond i at time t, a given monthly increment within our study window (January 16–August 21, 68 months). Within our study space, we utilise the matching method to find the hypothetical spread of a risky EUR-denominated bond, $h_{i,t}^{EUR}$, relative to the spread of an existing, observed and risky USD-denominated bond, $z_{i,t}^{USD}$ of an identical issuer within the our universe of corporate issuers contained in the iBoxx EUR Corporates Senior index and the iBoxx EUR Corporates Senior index, respectively [7]:

$$\Psi_{i,t} = z_{i,t}^{USD} - z_{h,t}^{EUR} \tag{4}$$

$z_{i,t}^{USD}$ is an observed value, given by the z-spread or "zero-volatility spread", of an existing USD-denominated bond, i, traded in the market. Hypothetical $z_{h,t}^{EUR}$ is implied from two otherwise theoretically identical neighbouring senior bonds from the same risky parent in the EUR-denominated market; $z_{h,t}^{EUR}$ is derived by interpolating between the z-spreads of the two closest neighbouring bonds to the duration of the observed bond i, from which we obtain $z_{i,t}^{USD}$.

Following the matching method, $z_{h,t}^{EUR}$ is implied from the z-spread of lower duration neighbouring bond, $z_{l,t}^{EUR}$, and the z-spread of higher duration neighbouring bond, $z_{u,t}^{EUR}$, where the referenced bonds are all subsets of the iBoxx EUR Corporates Senior index, simultaneously contained in the set of the bonds issued by a common risky parent, shared by bond i. To ensure eligibility for inclusion in the study at any given monthly increment, the bond universe must be pre-screened such that all constituents satisfy the inequality:

$$d_{l,t}^{EUR} \leq d_{i,t}^{USD} \leq d_{u,t}^{EUR} \tag{5}$$

where $d_{l,t}^{EUR}$ = Duration of bond l_t^{EUR}, $d_{i,t}^{USD}$ = Duration of bond i, $d_{u,t}^{EUR}$ = Duration of bond u_t^{EUR}. Of the eligible bonds, reference bond l_t^{EUR} should maximise $d_{l,t}^{EUR}$, whilst reference bond l_t^{EUR} should minimise $d_{u,t}^{EUR}$.

For bonds l_t^{EUR} and u_t^{EUR}, we observe their given z-spread, $z_{l,t}^{EUR}$ and $z_{u,t}^{EUR}$, respectively, which we reference in combination with their respective duration, $d_{l,t}^{EUR}$ and $d_{u,t}^{EUR}$, to solve for $z_{h,t}^{EUR}$, which is then given by

$$z_{h,t}^{EUR} = z_{l,t}^{EUR} + \frac{\left(d_{i,t}^{USD} - d_{l,t}^{EUR}\right) \cdot \left(z_{u,t}^{EUR} - z_{l,t}^{EUR}\right)}{\left(d_{u,t}^{EUR} - d_{l,t}^{EUR}\right)} \tag{6}$$

The interpolated z-spread is calculated as the spread that will render the present value of the cash flows of a respective (hypothetical) bond equal to the market dirty price when discounted by the benchmark spot rate plus the spread [8].

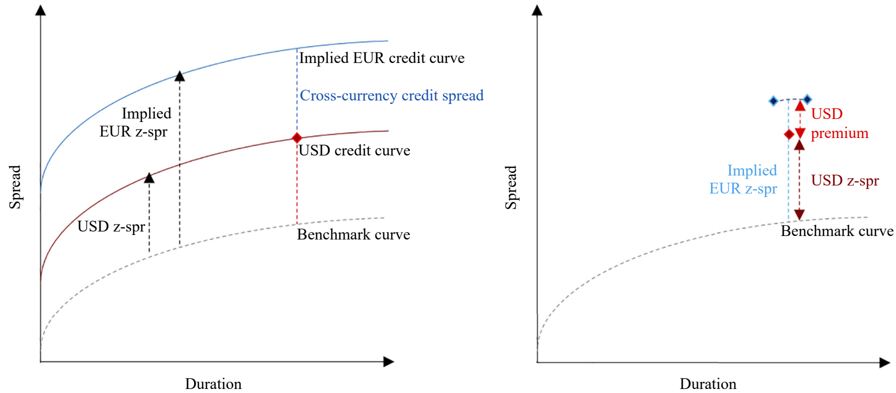
We can represent the CCCS, the perceived "USD pricing premium", graphically as the difference in the implied EUR z-spread (from an issuer's implied credit curve over the benchmark), relative to the z-spread of the observed USD-denominated bond, as illustrated in Figure 2.

In general, constant spread, $S_{i,j}$, over the spot curve, $z_t(L)$, for a bond at time t on an annual basis is calculated iteratively by using a root-seeking algorithm, the Newton–Raphson method (Raphson, 1702):

$$P_{i,t} + A_{i,t} = \sum_{j=1}^{n} CF_{i,j} \cdot \left(1 + z_t(L_{i,j}) + S_{i,j}\right)^{-L_{i,j}} \tag{7}$$

where $P_{i,t}$ = Clean price of bond i at time t, $A_{i,t}$ = Accrued interest of bond i at time t, $CF_{i,j}$ = Cash flow of bond i in the jth period, $z_t(L_{i,j})$ = Spot (benchmark) curve where z_t is the function constructed by natural splines with defined knots and $L_{i,j}$ represents the time in coupon periods for bond i at the j^{th} cash flow, $S_{i,j}$ = Constant spread above the curve such that present value of the cash flows equate to the observed market "dirty" price ($P_{i,t} + A_{i,t}$).

Notes on employing the matching method: interpolating between neighbouring instruments in both fixed income and swap markets is intended to provide an efficient and



Source(s): Author

Figure 2.
Stylised representation of the cross-currency credit spread

indicative estimation of the character of hypothetical comparators. Indeed, as the Euclidean distance between neighbouring instruments increases, so too does the model's residual error. The interpolation approach disregards the broader structure of an issuer curve, which captures the complexities of curve structure. To improve the fidelity of the reference curves and improve the resolution of such a study, researchers may consider applying iterative spline-based modelling or adopting a parametric curve-fitting approach, such as some derivative of the Nelson-Siegel-Svensson method, which would better reflect market pricing through the incorporation of additional curve dynamics. This is particularly helpful when assessing bonds from issuers with substantial gaps in their domestic and/or foreign curves or issuers with wider curves. The residual error is likely to be exacerbated by substantial variations in instrument liquidity across tenors.

2.2 Isolating the idiosyncratic basis

Having obtained the CCCS, we venture to discount the hypothetical CCB, implied from the EURUSD (float/float) swap market, to isolate the residual premia, which we generalise as the "idiosyncratic basis", $\delta_{i,t}$.

For each monthly increment, we derive the hypothetical CCB by interpolating between the basis of the two closest neighbouring swap tenors.

Referencing the matching method again, the hypothetical CCB, $\varPhi_{i,t}$, is implied from $SWAP_{l,t}$, the basis of neighbouring EURUSD (float/float) cross-currency swap of lower [9] tenor, l at time t and $SWAP_{u,t}$, the basis of neighbouring EURUSD (float/float) cross-currency swap of higher tenor, l at time t, where the referenced tenors must satisfy the inequality:

$$T_{l,t} \leq d_{i,t}^{USD} \leq T_{u,t} \tag{8}$$

where $T_{l,t}$ = Tenor of $SWAP_{l,t}$, $d_{i,t}^{USD}$ = Duration of bond b_t^{USD} and is equivalent to $d_{h,t}^{EUR}$ = Duration of hypothetical bond h_t^{EUR}, $T_{u,t}$ = Tenor of $SWAP_{u,t}$. Of the eligible swaps, $SWAP_{l,t}$ should maximise $T_{l,t}$, whilst $SWAP_{u,t}$ should minimise $T_{u,t}$.

For swaps $SWAP_{l,t}$ and $SWAP_{u,t}$, we observe their given basis, $\beta_{l,t}$ and $\beta_{u,t}$, respectively, which we reference in combination with their respective duration, $t_{l,t}$ and $t_{u,t}$, to solve for the implied CCB, $\varPhi_{i,t}$, which is then given by

$$\Phi_{i,t} = \beta_{l,t} + \frac{\left(d_{i,t}^{USD} - t_{l,t}\right) \cdot (\beta_{u,t} - \beta_{l,t})}{(t_{u,t} - t_{l,t})} \tag{9}$$

As such, the idiosyncratic basis, δ, can be represented as follows:

$$\delta_{i,t} = z_{i,t}^{USD} - z_{h,t}^{EUR} - \beta_{l,t} + \frac{\left(d_{i,t}^{USD} - t_{l,t}\right) \cdot (\beta_{u,t} - \beta_{l,t})}{(t_{u,t} - t_{l,t})} \tag{10}$$

This representation can be reduced to the following form:

$$\delta_{i,t} = \Psi_{i,t} - \Phi_{i,t} \tag{11}$$

We can represent the idiosyncratic basis, the residual risk premia, graphically as the difference between the CCCS and the hypothetical CCB derived from the two closest neighbouring (float/float) EURUSD swaps, as illustrated in Figure 3. The tenor, t, of $\Phi_{i,t}$ is naively matched to the duration, t, of $\Psi_{i,t}$ to simplify the inconsistencies of the cash flows and holding periods of both instruments; $\Phi_{i,t}$ is merely a proxy for gauging funding demand and supply imbalances and, by extension, the directional deviation of the idiosyncratic basis.

3. Harvesting the idiosyncratic basis

Computing the idiosyncratic basis over the 68-month study window reveals that this basis does not always represent a pricing premium to USD-denominated bonds relative to their comparators, but sometimes also a discount, demonstrating an optically balanced distribution of discount and premium values. The mean and median of the 3,443 historical idiosyncratic observations indicate a bias towards a USD premium 1.33 bps and 1.51 bps, respectively, and a range of 128.98 bps; a material balanced basis distribution presents headroom to harvest alternative risk premia (ARP), as the basis tends towards zero, across

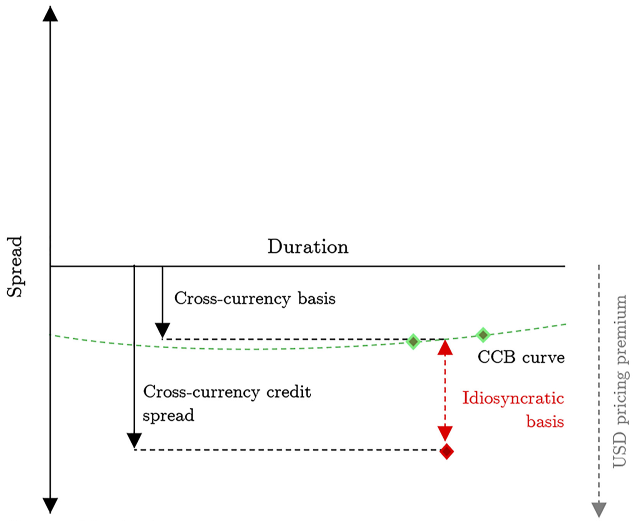


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Figure 3. Stylised representation of the idiosyncratic basis

both base and quote currency-denominated markets [10]. Each security at time t across the study window has its CCB, $\Phi_{i,t}$, CCCS, $\Psi_{i,t}$, and idiosyncratic basis, $\delta_{i,t}$, plotted in Figure 4.

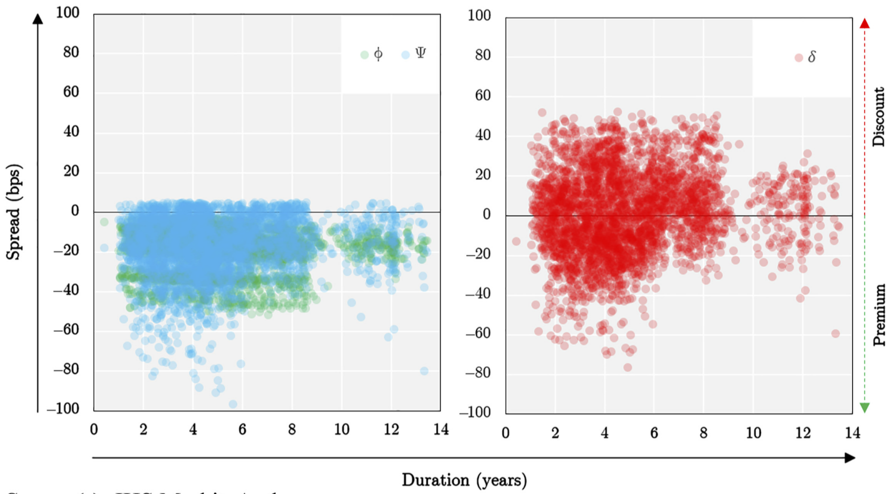
Having isolated the idiosyncratic basis, we define a theoretical static arbitrage strategy to harvest the positive and negative idiosyncratic basis across quintiles; the success of a static arbitrage strategy to harvest basis would indicate that the basis adheres, to some extent, to the no-arbitrage condition and that it tends to zero over time.

Our strategy first ranks the idiosyncratic basis for each given bond, which we identify by their respective International Securities Identification Number (ISIN), at each month end. Based on the ranking, each ISIN is assigned to a quintile, ranging from Quintile 1 (Q1), which represents the highest idiosyncratic basis (degree of USD premium), to Quintile 5 (Q5), which represents the lowest idiosyncratic basis. The baskets are re-ranked at each month end to ensure that the strategy is dynamic, preventing survivorship bias. Each quintile is tracked for a month, at the end of which period the idiosyncratic basis for the reference ISINs is recomputed. An absolute change in basis is derived, and a basket average is noted for the month, mimicking the return of an equal-weighted basket. The results are displayed in Figure 5 and a breakdown of basis harvesting by sector and quintile is available in Appendix 1, with accompanying descriptive statistics available in Appendix 2.

The cumulative change in the dynamic basket's idiosyncratic basis suggests a mean-tendency of the quintiles over time (a consistent walk towards zero or to the sample mean). This demonstrates some adherence to the no-arbitrage principal. Critically, the path of the idiosyncratic basis demonstrates consistency across the study window, although the rate at which the idiosyncratic basis is harvested across all quintiles seems to increase in the first half of 2020, a characteristically risk-off period.

Establishing the nature of each quintile, we build long (+) and short (−) idiosyncratic basis portfolios, based on the net harvested idiosyncratic basis over the study window. For each of our five quintile portfolios, the entire (indexed) value of the portfolio is equally weighted across the quintile of idiosyncratic basis opportunities. The portfolio is rebalanced on a monthly basis.

Adjusting the total return of the quintile portfolios to determine excess returns [12], it is clear that a pure strategy that seeks only to capture the idiosyncratic basis fails to consistently outperform the risk free rate and is not suitable as a standalone exposure, despite



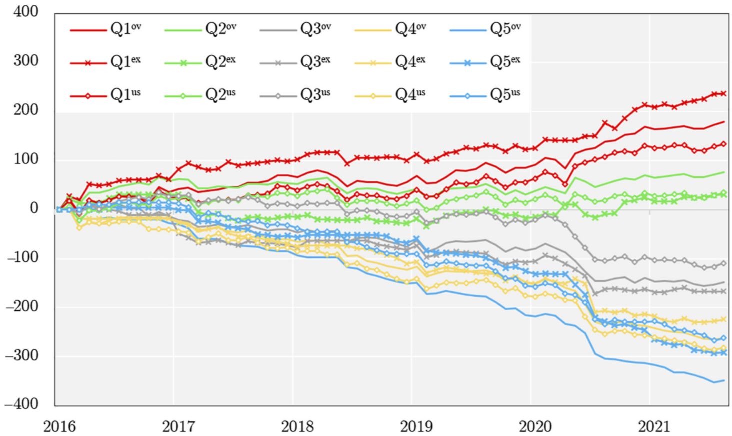
Source(s): IHS Markit, Author

Figure 4.
Visualising the distribution of spreads across the study window

its favourable information ratio. However, anchoring the idiosyncratic basis to zero has demonstrated a consistency over time (Figure 6) and, intriguingly, has outperformed the proxy risk-free rate in our risk-off period (Figure 7).

A breakdown of the descriptive statistics relating to the total return of the dynamic portfolios corresponding to the identified idiosyncratic basis quintile baskets is available in Table 1.

Whilst a pure exposure to the idiosyncratic does not offer compelling risk-adjusted returns, the results merit further research into the optimisation of traditional market-directional portfolios to capture this additional premium. The idiosyncratic basis may offer some insurance in risk-off periods (if the COVID-induced sell-off is indicative of typical risk-off behaviour); the pure idiosyncratic basis strategy outperformed the risk-free rate in our risk-off window, hence optimising to capture this exposure may provide a countercyclical



Source(s): IHS Markit, Author

Figure 5. Cumulative change in the dynamic basket idiosyncratic basis [11]

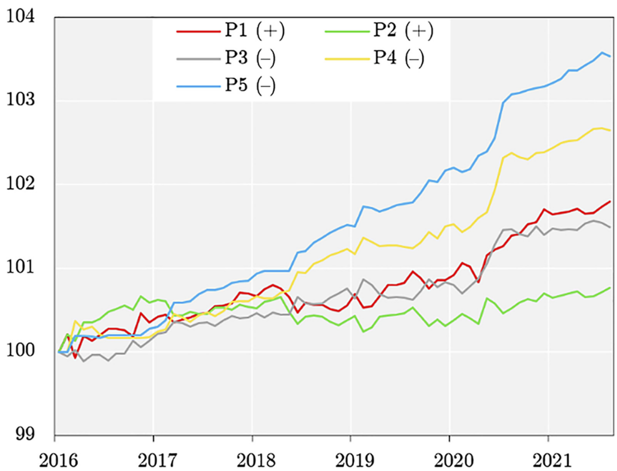


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Figure 6. Cumulative basis harvested

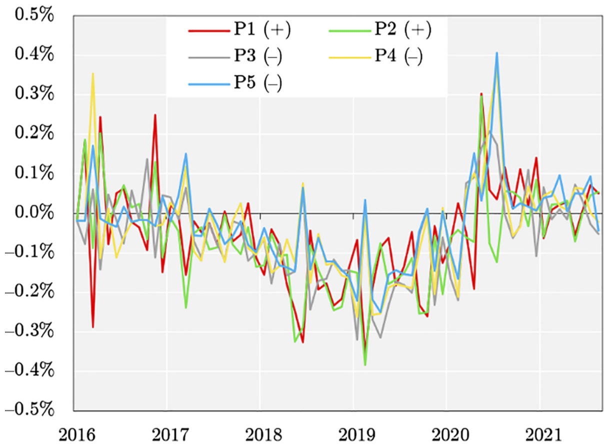

Figure 7.
Excess basis harvested

Table 1.
Descriptive statistics for quintile portfolio returns

	USD premium ⇔ EUR premium				
	P1 (+)	P2 (+)	P3 (–)	P4 (–)	P5 (–)
Mean	0.03%	0.01%	0.02%	0.04%	0.05%
Standard error	0.01%	0.01%	0.01%	0.01%	0.01%
Median	0.03%	0.02%	0.01%	0.02%	0.03%
Standard deviation	0.10%	0.09%	0.08%	0.09%	0.08%
Sample variance	0.00%	0.00%	0.00%	0.00%	0.00%
Skewness	0.05	0.36	0.49	1.69	2.19
Excess kurtosis	1.15	1.65	–0.09	4.07	6.97
Range	0.59%	0.49%	0.36%	0.48%	0.46%
Minimum	–0.27%	–0.18%	–0.13%	–0.10%	–0.05%
Maximum	0.31%	0.31%	0.23%	0.38%	0.41%
Sum	1.78%	0.77%	1.48%	2.62%	3.48%
Observations	67	67	67	67	67
Jarque–Bera	3.72	9.06	2.74	78.21	188.93
p-value	0.156	0.011*	0.255	0.000**	0.000**

Note(s): *$0.01 < p < 0.05$; **$p < 0.01$

portfolio buffer alongside the seemingly consistent basis harvesting across the credit cycle. Understanding the co-movement of this premium to other risk and return factors is critical to understanding whether tilting directional portfolios towards this factor is accretive or dilutive to total and risk-adjusted return, as tilting portfolios to capture this premium will have an impact on portfolios' factor exposure profile.

4. Conclusion

This paper identifies the "idiosyncratic basis". Conceptually, the idiosyncratic basis is derived from calculating the residual spread differential between a bond and a hypothetical comparator [13], denominated in a different currency, and adjusting for the CCB of the referenced bond's currency denomination relative to the currency denomination of the hypothetical comparator. In the case of this study, we consider the pricing of eligible bonds in the iBoxx USD Corporates Senior Index in relation to their respective hypothetical comparators in the iBoxx EUR Corporates Senior Index, constraining our study environment to sufficiently large, relatively liquid and tradeable instruments.

Whilst the CCB has failed to be anchored to zero, thus consistently violating the assumed no-arbitrage condition, this study finds that the residual premia isolated in the idiosyncratic basis behave differently in the aggregate, tending over time in the aggregate towards zero (or towards the sample mean, which is close to zero). The performance of a pure strategy is consistent and indicates a positive contribution to portfolio returns from allocating to this idiosyncratic basis return stream in isolation; however, a pure strategy fails to consistently overcome the 1-month US T-Bill hurdle rate, and co-movement with other risk and return factors is yet to be explored.

Whilst a pure strategy does not deliver a compelling risk-adjusted return, even prior to computing net returns adjusted for transaction costs [14], investors should note the potential additive contribution of optimising traditional market-directional portfolios to capture the idiosyncratic basis. Aside from harvesting the consistent basis, optimisation towards the idiosyncratic basis may offer some insurance in risk-off periods (assuming that our sample risk-off period, the COVID-induced sell-off, reflects the typical behaviour of the idiosyncratic basis in other sell-off regimes); optimising allocation to this exposure may provide a countercyclical portfolio return buffer in addition to the seemingly consistent basis harvesting across the credit cycle.

This paper proposes the consideration of the idiosyncratic basis as an additional class of ARP, to be targeted by credit investors in pursuit of enhanced portfolio returns.

Notes

1. Indeed, this deviation became particularly pronounced amid the COVID-induced funding crunch (Figure 1).
2. *Inter alia*, capital controls as illustrated in the case of Japan (Otani and Tiwari, 1981).
3. *Inter alia*, Pinnington and Shamloo (2016), Mancini-Griffoli and Ranaldo (2010) and Ivashina *et al.* (2015) find evidence of funding liquidity evaporation in times of crises adding the effective cost of trading.
4. *Inter alia*, arbitrageurs' behavioural restraint from engaging opportunities in times of elevated market volatility (Shleifer and Vishny, 1997).
5. https://ihsmarkit.com/products/valuation-services.html
6. https://ihsmarkit.com/products/iboxx.html; the iBoxx indices provide us with a constrained universe of sufficiently large, relatively liquid tradeable fixed income instruments.
7. Ψ_t is expressed in basis points, where a negative value indicates a pricing premium of the observed risky USD-denominated bond, $z_{i,t}^{USD}$.
8. The "dirty price" accounts for the accrued interest, whereas the "clean price" discounts the accrued interest.
9. "Lower" and "higher" are relative concepts relating to the Euclidean distance of the available swap universe relative to the duration of the reference bond, $d_{i,t}^{USD}$. The neighbouring concept is further articulated in expression (5) and the subsequent note.
10. The prospect of multi-directional opportunities within an individual base or quote currency-denominated market is materially encumbered by the cost of short-selling credit market instruments.
11. Where Q_n^{us} = Quintile n of bonds where the country of risk is the USA, Q_n^{ov} = Quintile n of bonds from the entire study universe and Q_n^{ex} = Quintile n of bonds where the country of risk is outside of the USA. $1 \leq n \leq 5$, where $n = 1$ represents the highest degree of idiosyncratic basis (USD premium) and $n = 5$ represents the lowest degree of idiosyncratic basis premium.
12. The US 1-month T-Bill is used as a risk-free rate proxy, in-line with the portfolio's month-end rebalancing schedule.

13. A hypothetical comparator is the interpolated result of two observed bonds of identical credit risk and seniority, interpolated to derive the implied z-spread at the point at which the duration of the hypothetical comparator is equal to the eligible reference bond.
14. Asquith *et al.* (2013) provide a discussion in particular on the cost of borrowing bonds to construct a short position.

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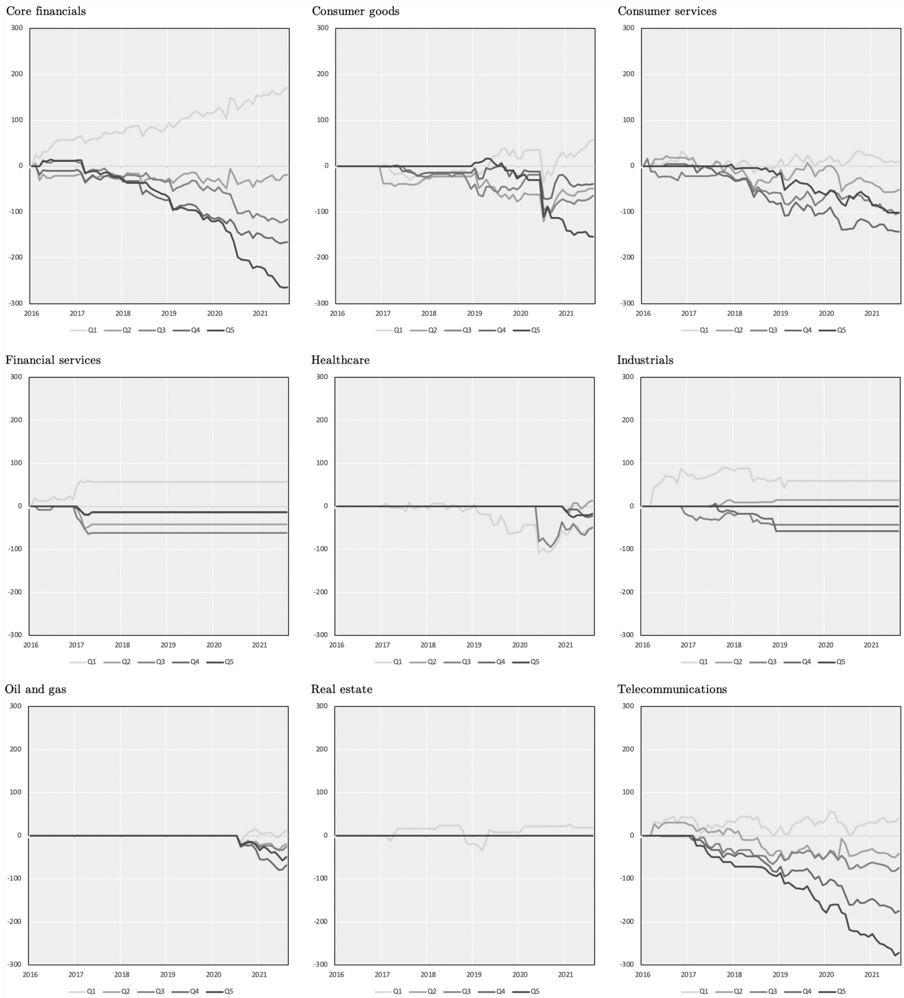
Appendix 1



Source(s): IHS Markit, Author

Figure A1.
Sector-based performance by dynamic quintile

Appendix 2

Table A1. Descriptive statistics for monthly idiosyncratic basis harvesting by sector and quintile

	CorFin Q1	CorFin Q2	CorFin Q3	CorFin Q4	CorFin Q5	ConGds Q1	ConGds Q2	ConGds Q3	ConGds Q4	ConGds Q5	ConSrv Q1	ConSrv Q2	ConSrv Q3	ConSrv Q4	ConSrv Q5
Mean	2.52	−0.27	−1.71	−2.43	−3.89	0.83	−0.72	−0.95	−0.57	−2.27	0.14	−0.76	−1.50	−2.11	−1.49
Standard error	1.23	1.26	0.88	0.93	0.93	1.48	1.44	1.43	1.26	1.40	1.12	1.23	1.06	1.06	0.89
Median	2.03	0.00	−0.41	0.00	−1.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard deviation	10.13	10.39	7.24	7.67	7.69	12.20	11.88	11.83	10.43	11.56	9.27	10.14	8.71	8.72	7.32
Sample variance	102.66	107.92	52.42	58.86	59.18	148.76	141.22	139.96	108.77	133.64	85.89	102.85	75.83	75.97	53.51
Kurtosis	4.87	5.52	1.64	1.95	3.60	16.39	9.62	27.10	15.19	31.79	0.14	1.47	0.97	0.93	8.39
Skewness	0.85	0.10	−1.07	−1.14	−1.70	−2.80	−2.22	−4.20	−2.21	−4.85	−0.13	−0.69	−0.54	−0.53	−1.51
Range	68.82	79.89	35.61	39.56	43.40	95.13	87.20	98.89	90.06	102.00	48.58	55.39	45.88	44.55	58.18
Minimum	−22.41	−36.91	−22.99	−28.77	−33.01	−69.97	−58.56	−78.12	−58.61	−80.44	−26.46	−36.58	−28.00	−27.88	−36.58
Maximum	46.40	42.99	12.62	10.79	10.39	25.15	28.64	20.77	31.44	21.56	22.11	18.81	17.89	16.67	21.60
Sum	171.29	−18.48	−116.23	−165.45	−264.34	56.51	−49.29	−64.67	−38.59	−154.06	9.35	−51.41	−102.25	−143.28	−101.50
Count	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68

	Finsrv Q1	FinSrv Q2	FinSrv Q3	FinSrv Q4	FinSrv Q5	HltCre Q1	HltCre Q2	HltCre Q3	HltCre Q4	HltCre Q5	Indust Q1	Indust Q2	Indust Q3	Indust Q4	Indust Q5
Mean	0.84	−0.62	−0.91	−0.20	−0.20	−0.70	0.20	−0.72	−0.32	−0.25	0.87	0.21	−0.62	−0.84	0.00
Standard error	0.64	0.51	0.52	0.19	0.22	1.53	0.43	1.43	0.26	0.25	1.15	0.20	0.48	0.51	0.00
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard deviation	5.24	4.24	4.29	1.56	1.83	12.59	3.54	11.80	2.18	2.04	9.52	1.66	3.95	4.21	0.00
Sample variance	27.45	17.97	18.43	2.44	3.35	158.49	12.53	139.17	4.75	4.17	90.68	2.76	15.62	17.74	0.00
Kurtosis	20.23	34.13	17.24	18.70	24.46	10.12	18.54	34.59	16.19	21.95	10.41	8.99	9.28	30.32	N/A
Skewness	3.93	−5.65	−3.80	−1.80	−4.20	−2.10	1.65	−4.60	−3.11	−4.10	1.39	0.60	−2.12	−5.06	N/A
Range	39.52	34.47	32.85	15.23	15.49	91.94	33.19	115.20	18.09	16.21	76.01	12.17	27.06	35.25	0.00
Minimum	−7.84	−28.73	−24.85	−8.55	−10.12	−65.89	−13.31	−81.75	−11.87	−11.60	−30.33	−5.81	−18.85	−28.40	0.00
Maximum	31.69	5.74	8.00	6.68	5.37	26.05	19.88	33.45	6.22	4.61	45.69	6.35	8.20	6.86	0.00
Sum	57.31	−41.84	−61.78	−13.30	−13.62	−47.41	13.39	−49.10	−21.73	−17.21	59.15	14.61	−42.37	−57.07	0.00
Count	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68

(*continued*)

Table A1.

	OilGas Q1	OilGas Q2	OilGas Q3	OilGas Q4	OilGas Q5	RelEst Q1	RelEst Q2	RelEst Q3	RelEst Q4	RelEst Q5	Telcom Q1	Telcom Q2	Telcom Q3	Telcom Q4	Telcom Q5
Mean	0.19	−0.29	−0.38	−1.00	−0.73	0.28	0.00	0.00	0.00	0.00	0.60	−0.62	−1.10	−2.56	−3.99
Standard error	0.43	0.44	0.38	0.57	0.49	0.84	0.00	0.00	0.00	0.00	1.28	1.36	0.98	0.93	0.99
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00
Standard deviation	3.56	3.65	3.13	4.74	4.04	6.89	0.00	0.00	0.00	0.00	10.59	11.24	8.07	7.68	8.20
Sample variance	12.65	13.36	9.80	22.46	16.30	47.50	0.00	0.00	0.00	0.00	112.24	126.36	65.19	58.98	67.27
Kurtosis	8.32	14.34	27.45	15.47	11.96	8.98	N/A	N/A	N/A	N/A	0.94	5.87	0.52	0.80	3.06
Skewness	−0.58	−2.66	−4.01	−3.53	−2.71	0.42	N/A	N/A	N/A	N/A	−0.24	1.15	−0.58	−0.78	−1.19
Range	27.21	30.11	28.67	34.81	29.88	57.64	0.00	0.00	0.00	0.00	58.05	77.50	38.39	35.56	52.80
Minimum	−14.50	−19.81	−20.60	−25.30	−21.78	−28.32	0.00	0.00	0.00	0.00	−25.75	−27.10	−22.39	−23.24	−35.42
Maximum	12.71	10.30	8.07	9.51	8.09	29.32	0.00	0.00	0.00	0.00	32.30	50.41	16.00	12.32	17.38
Sum	12.86	−19.99	−25.64	−68.34	−49.47	18.87	0.00	0.00	0.00	0.00	40.79	−41.83	−74.48	−174.25	−271.28
Count	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68