Dash for Dollars

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Abstract

We provide evidence on the special status of the US dollar in the international monetary and financial system by studying the disruption in corporate debt markets during the Covid-19 outbreak. Within-firm variation of corporate bond spreads from a new multi-country data set shows that US dollar-denominated bonds experienced larger increases in spreads relative to non-dollar bonds. The patterns we uncover suggest a 'dash for dollars', in which investors in need of cash dollars sold their dollar-denominated assets first, with a consequent impact on prices. We then exploit a rich transaction-level regulatory data set to link these dynamics to the dominant role of the US dollar in the international monetary and financial system. Our results suggest that investors needed dollar cash in order to meet immediate dollar obligations.

Keywords: Heterogeneity, Credit spreads, Liquidity, Dash-for-cash, US dollar, Covid-19, Event-study, Identification.

JEL Codes: E44, E58, G01, G12, G15, G18.

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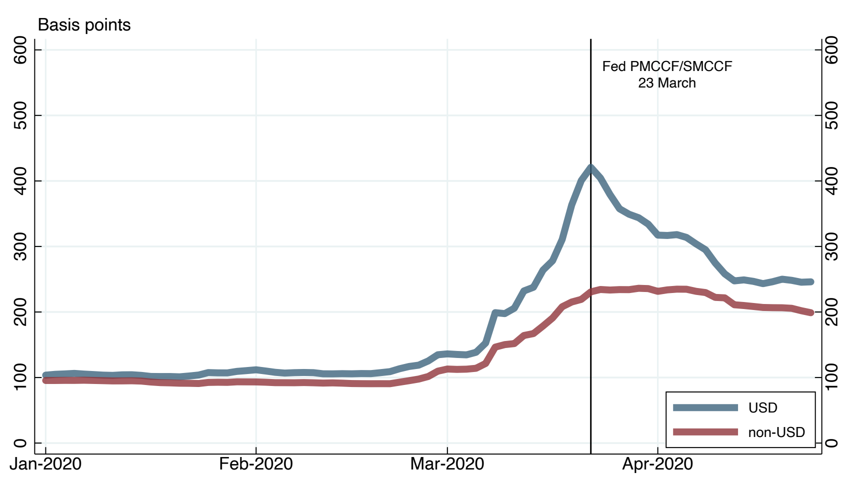
1 Introduction

Global corporate bond markets were under severe distress during the outbreak of the Covid-19 pandemic. Corporate bond spreads widened sharply between late February, when the rate of expansion of Covid-19 accelerated worldwide, and mid-March, when the Fed announced a series of measures to ease conditions in financial markets. While the dramatic widening of credit spreads caught the attention of most commentators, another defining feature of the stress period was how highly heterogeneous the increase in spreads across bonds was.

What bond characteristics are associated with the heterogeneous dynamics of bond spreads? In this paper, we focus on the currency of denomination of bond spreads, a dimension that existing studies have so far overlooked. We start by uncovering a novel empirical pattern, namely that bonds denominated in US dollars experienced significantly larger increases in spreads relative to bonds denominated in other currencies. Figure 1 reports a comparison of average spread dynamics for dollar and non-dollar bonds in a large multi-country data set on corporate bonds around the Covid-19 outbreak.

Figure 1 CORPORATE BOND SPREADS DURING COVID-19: DOLLAR VS. NON-DOLLAR



NOTE. Average of option adjusted corporate bonds spreads across all outstanding bonds in US dollars and non-US dollars, respectively. Source: ICE Bank of America Merrill Lynch.

The figure shows that, as the expansion of Covid accelerated, the spread of dollar bonds rose significantly faster than the spread on non-dollar bonds. Of course, simple unconditional averages (as those reported in Figure 1) are only illustrative. They could be driven, for instance, by selection dynamics leading firms to issue bonds of a specific size or maturity when doing so in US dollars. Similarly, at a more aggregate level, a larger widening in the spread of US dollar bonds could be driven by riskier firms selecting into US dollars bonds issuance.

In order to study this dynamic in more detail, we construct a new global data set with information on more than $9,000$ corporate bonds issued by almost $2,000$ non-financial corporations, covering more than 50 countries and 6 major international currencies. To inform our empirical estimates, we exploit a unique feature of our data, namely that firms have multiple outstanding bonds with heterogeneous characteristics. By exploiting within-firm variation across bonds, we are effectively controlling for firm-level heterogeneity in analyzing spread dynamics, hence circumventing problems associated with unobserved correlations that are hard to control for—for example, if certain types of firms systematically issue bonds with particular characteristics.

We conjecture that the asymmetric dynamics between dollar and non-dollar bonds uncovered in this paper are ultimately related to the role of the US dollar as a 'dominant currency' in the international monetary and financial system. There are, in particular, two dimensions of this special status that could be related to our findings. The first one is the dollar's superior liquidity, which can lead to an increased sale of dollar-denominated securities during times of stress so as to minimize fire-sale costs.[1]

[1] Haddad et al. (2021), among others, interpret larger increase in spreads of more liquid bonds in the US as the result of selling pressures from bond investors trying to obtain cash, a so-called 'dash for cash'. In response to such shock, investors sold their assets following a pecking order of liquidity, selling their most liquid assets first in order to minimize the adverse price impact of fire-sales—a phenomenon that has been dubbed a 'reverse flight to liquidity' (Ma et al., 2022). If intermediaries do not have capacity or willingness to absorb the resulting increase in supply, such selling pressure can lead to the price dynamics observed in the data, in which more liquid securities end up displaying larger falls in prices (and, hence, increases in spreads) than less liquid ones.

The second dimension is related to the use of the US dollar as a unit of account. One aspect of this property is the widespread denomination of financial and real liabilities in US dollars, which means that agents need to secure US dollars when these liabilities become due, including in stress periods (for example to meet margin calls, investor redemptions, etc). If, at the same time, the cost of hedging FX exposures is high—as it is typically the case during periods of stress, including the one induced by Covid-19, as shown by a sharp widening of CIP deviations—then investors would find it optimal to sell US dollar-denominated assets first.

To shed light on the relevance of these channels, we exploit data from the transaction-level MiFID II database, maintained by the UK's Financial Conduct Authority (FCA). The MiFID II data provide detailed reports of all secondary-market trades of firms regulated in the UK.[2] Armed with this much richer data set, we first show that the increase in dollar spreads is associated with increased selling of dollar bonds by investors. Importantly, the granularity of our data set allows us to compare trades of the same client, on the same day, across different bonds of the same issuer. While we find no significant difference in investors' net purchases, our results show that dollar bonds (particularly investment grade bonds) were sold off in larger volumes than non-dollar bonds—consistent with both channels described above.

We then shed some light on the importance and interconnectedness of the two mechanisms. The first mechanism (dollar as 'dominant' medium of exchange), puts the role of dollar bonds' superior liquidity at the forefront. Due to the relatively low liquidation costs of dollar bonds, investors can minimize fire-sales losses by liquidating dollar bonds first. However, when comparing effective bid-ask spreads of dollar vs. non-dollar bonds, we find that bid-ask spreads of dollar bonds reached levels of more than 100 basis points in mid-March, and were substantially higher ($\sim$20 basis points) compared to those of non-dollar

[2] Each transaction report contains information on the transaction date and time, ISIN, execution price, transaction size, and the legal identities of the buyer and seller.

bonds. Importantly, this difference is not only observable on an aggregate level, but also when controlling for all unobserved firm-level characteristics, hence comparing effective bid-ask spreads of bonds of the same issuer and on the same day. The data, thus, seem to suggest a "liquidity inversion", where usually more liquid dollar bonds experienced larger price drops than their more illiquid counterparts (see also Haddad et al., 2021; Ma et al., 2022). This surprising observation suggests that other factors—beyond a bond's price and liquidity—may have contributed to the selling pressure in dollar bonds.

Consistent with this view, the second mechanism (dollar as 'dominant' unit of account) puts the role of dollar funding at the forefront. According to this mechanism, investors sell dollar assets to meet immediate dollar obligations. To test this channel, we exploit a particular feature of the Covid-19 crisis, namely that UK insurers were exposed to high and unexpected liquidity demands due to large variation margin (VM) calls (Czech et al., 2021). Importantly, investors are typically required to meet VM calls in the currency of the derivative contract, and many UK insurers tend to have large exposures to dollar-denominated derivative contracts. Using additional granular data on UK insurers' derivative holdings, we find that insurers with a high share of dollar-denominated derivative contracts sold off significantly higher quantities of dollar bonds compared to less exposed insurers, thereby lending strong support to the dollar funding mechanism. These results reinforce our interpretation that both channels likely contributed to the sell-off of dollar bonds during Covid-19: while some investors may have sold dollar assets primarily to minimize their transaction costs, others had to meet dollar-denominated obligations, which further heightened the selling pressure — akin to a "perfect storm" for liquid dollar assets.

Related literature. Our findings speak directly to studies analyzing the dynamics of corporate bond spreads and liquidity during the Covid-19 pandemic (e.g. O'Hara and Zhou, 2021; Haddad et al., 2021; Kargar et al., 2021; Gilchrist et al., 2020; Ebsim et al., 2020;

Boyarchenko et al., 2022).[3] In particular, Haddad et al. (2021) highlight the role of the "dash for cash" in explaining the dynamics of corporate bond spreads during the outbreak, in turn linking it to a "reverse flight to liquidity" (see also Ma et al., 2022). According to this interpretation, investors in need of cash sold their most liquid securities first to minimize the price impact of their fire sales, nevertheless exerting downward pressure on the prices of these liquid bonds.[4] We complement those explanations by providing evidence that investors' behavior did not constitute a dash for cash in general, but a dash for US dollars in particular.

Furthermore, unlike prior studies on the US corporate bond market that use low-frequency investor holdings and anonymous trading data (e.g. Haddad et al., 2021; Kargar et al., 2021; O'Hara and Zhou, 2021; Boyarchenko et al., 2022; Ma et al., 2022), we exploit the regulatory MiFID II bond transaction database from the UK. The main advantage of our data is that we are able to observe the identities of both counterparties involved in a trade, hence allowing us to delineate the trading patterns and motives during the Covid-19 crisis: which groups of investors were buying, which were selling, and the associated impact on prices and liquidity. Importantly, we are then also able to link it back to the nature of investors' liabilities—and we show that the selling pressure was partly due to investors having to meet dollar liabilities, contributing to an "inversion" in the liquidity of dollar bonds.

Our results, hence, constitute complementary evidence to studies analyzing US dollar shortages around the Covid-19 outbreak (see, among others, Avdjiev et al., 2020; Eren et al., 2020; Bahaj and Reis, 2020), but shifting the focus from exchange rate markets to corporate bond markets. In a related paper, Liao (2020) studies the link between within-firm corporate bond spread differentials across currencies and deviations from the CIP condition in FX markets. While he focuses on relative currency dynamics at the business cycle frequency, we instead point to absolute directional differences between the US dollar and other currencies

[3]A broader literature has exploited the variation in asset prices induced by the Covid-19 outbreak to learn about a variety of transmission mechanisms. See, for example, Gormsen and Koijen (2020), Jiang et al. (2022) and Croce et al. (2020), among others.

[4]This hypothesis has also been put forward in the case of US treasury bonds (He et al., 2022).

during a period of stress. Additionally, Liao (2020) puts emphasis on the consequences for corporate bond issuance, while being agnostic about the origin of pricing anomalies in corporate spreads and FX derivative markets. We instead analyze a period during which the market for issuance was effectively shut, and therefore naturally focus on investors' rather than issuers' behavior.

2 The Dash for Dollars

In this section, we analyze the role of the US dollar in explaining the heterogeneous response of corporate bond spreads to the outbreak of the Covid-19 pandemic.

2.1 Data

In order to conduct our analysis, we build a large global data set of individual corporate bond spreads at daily frequency for the period of January-April 2020. We include bonds which are the constituents of a comprehensive global index of investment grade corporate bonds, the ICE Bank of America Merrill Lynch's Global Corporate Index.

Our initial data set includes daily data for more than $14,500$ investment grade bonds with a residual maturity above one year, issued by about $2,900$ companies in 60 countries. The main variable of interest for our study is a bond's Option Adjusted Spread (OAS).[5] The data set also contains information on other bond characteristics, such as the maturity of the bond, its currency of denomination, coupon, seniority and rating. The bonds considered are denominated in a range of currencies. US dollar-denominated bonds dominate, comprising 65.7% of the sample, followed by euro (23.6%), sterling (4.8%), Canadian dollar (4.3%), and Australian dollar (1.7%). To shed light on the role played by firm characteristics in explaining

[5]The OAS is defined as the number of basis points that the government spot curve is shifted to match the present value of discounted cash flows to the corporate bond's price. For details on the calculation of the OAS, see https://www.theice.com/market-data/indices.

the heterogeneity in the reaction of corporate bond spreads to the Covid-19 shock, we also merge the bond database described above with data on issuers' balance sheets coming from Eikon.

For the empirical analysis, to focus on real economy firms, we exclude bonds issued by firms in the banking and financial services industries. Furthermore, we focus on senior unsecured bonds. A unique feature of our data set, which is central to our identification strategy, is the fact that many firms have multiple outstanding bonds at any given point in time. As the main focus of the analysis is on a bond's currency of denomination, we only keep 'multi-currency' firms, i.e. firms that have at least one dollar-denominated bond and one non-dollar-denominated bond. The sample period we use in our baseline empirical exercise runs from February 28th to March 20th 2020. February 28th is an arbitrary starting point that aims to capture the end of relatively tranquil market conditions, and the end-point of March 20th corresponds to the last trading day before the Fed's announcement of its corporate bond purchase programs.[6] This leads to a final daily data set comprising $3,107$ bonds issued by 225 firms in 29 countries

Table 1 reports the summary statistics for the dollar and non-dollar bonds in our sample. As shown in Figure 1, dollar bonds experienced a larger increase in spreads. The table also shows that dollar bonds have a larger face value, a higher coupon, and a longer maturity than non-dollar bonds. Appendix A provides more details on both data sets and Appendix B provides a set of additional summary statistics and stylized facts.

[6] All our results are robust to alternative ending dates for our exercise. See Appendix C.

Table 1 Summary Statistics: Dollar vs. Non-dollar Bonds

	Δ Spread (28feb-20mar)	Face value	Coupon	Maturity (years)
	Dollar bonds			
Mean	241	997	4.0	10.9
Median	207	750	3.9	6.9
Standard Dev.	171	756	1.3	9.2
25th Percentile	143	500	3.1	3.2
75th Percentile	297	1250	4.7	19.1
	Non-dollar bonds			
Mean	111	728	2.3	7.2
Median	94	674	1.8	5.7
Standard Dev.	84	334	1.6	5.6
25th Percentile	77	500	1.1	3.4
75th Percentile	122	1000	3.1	9.0

Note. Summary statistics for dollar and non dollar bonds. The sample period covers the period between 28th and March 20th 2020. The sample consists of 3,107 bonds issued by 216 firms in 29 countries, for a total of 48,252 observations.

2.2 Baseline Results

We start by estimating a simple cross-sectional regression to gauge the role of the US dollar in explaining the increase in corporate bonds spreads during the Covid crisis:

$$\Delta s_{b,i} = \alpha + \alpha_i + \beta_1 USD_{b,i} + \Gamma X_{b,i} + \varepsilon_{b,i} \tag{1}$$

where $\Delta s_{b,i}$ is the change between February 28th and March 20th in the (option-adjusted) spread of bond b issued by firm i.[7] $USD_{b,i}$ is our main variable of interest, i.e. a dummy variable that identifies US dollar-denominated bonds. $X_{b,i}$ include a set of additional bond-level control variables, including the bond face value, initial spread level, coupon type, time-to-maturity and amortization type. Finally, α_i is a firm fixed effect, i.e. a dummy variable that controls for unobserved time-invariant heterogeneity at the firm level.

[7] As equation (1) employs only cross-sectional variation, the variables have no time subscripts.

It follows that, in equation (1), the coefficient β_1 is estimated using data *within* firms, i.e. exploiting variation across bonds issued by the same firm in different currencies. This constitutes one of the main advantages of our approach and data, and plays an important role in the interpretation of our results. Exploiting variation within firms, the β coefficients in our bond level regression are estimated keeping the fundamentals of the firm fixed.[8] This means that the different behavior of spreads in the dollar and non-dollar buckets cannot be attributed to a systematic relation between currency of denomination and firms' characteristics (which would arise, for example, if low-risk firms would systematically issue non-dollar bonds).

Table 2 Bond Spreads Widening: Role of the US Dollar

	(1)	(2)
US dollar (β_1)	120.41***	7.84***
	(7.68)	(2.56)
Observations	2927	50685
R^2	0.649	0.356
Number of Firms	221	225
Firm FE	yes	no
Firm-Time FE	no	yes
Double clustering	no	yes

Note. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Coefficients corresponding to the constant, fixed effects, level of credit spread at the beginning of the sample, coupon type dummies, amortization type dummies, bond face value, and maturity not reported.

The results from specification (1) are reported in Table 2, Column (1). The coefficient estimates show that US dollar-denominated bonds are associated with a larger increase in corporate bond spreads, in line with the unconditional evidence reported in Figure 1. Specifically, spreads of dollar bonds increased by about 116 basis points more than non-dollar bonds.

[8] For example, Gilchrist and Zakrajsek (2012) regress credit spreads on a measure of distance to default computed using Merton's model. Our approach would absorb the change in the default probability of a firm without taking a particular stance on the right measure of default probability to use. We discuss these issues in more detail in Section 3.

Next, we exploit the daily nature of our data set and estimate the following panel specification:

$$\Delta s_{b,it} = \alpha + \alpha_{it} + \beta_1 USD_{b,i} + \Gamma X_{b,i} + \varepsilon_{b,it} \quad (2)$$

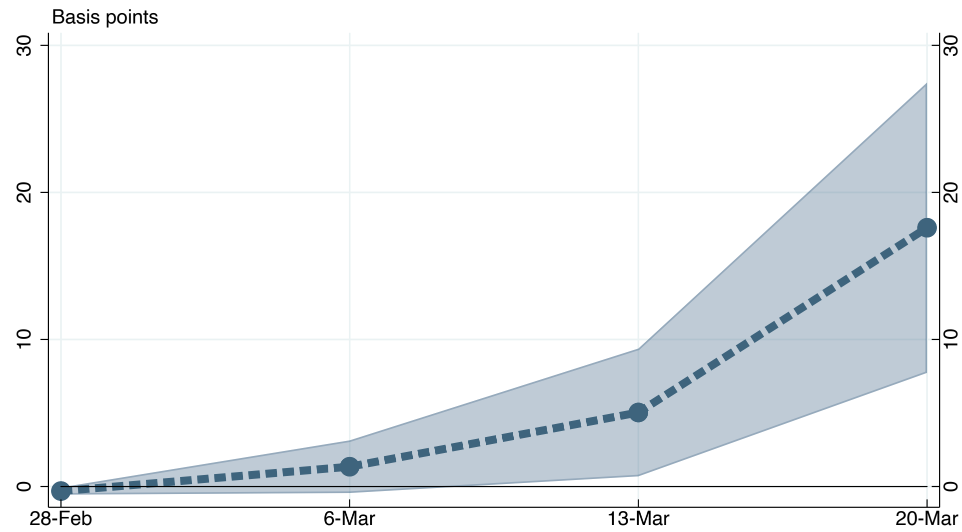
where $\Delta s_{b,it}$ is the daily change between February 28th and March 20th in the (option-adjusted) spread of bond b issued by firm i. Differently from the cross-sectional specification (1), the panel specification (2) includes a firm-time fixed effect (α_{it}) which controls for unobserved *time-varying* heterogeneity at the firm level. That is, the effect of currency of denomination is estimated exploiting variation of spreads within a firm on a given day (rather than in the whole stress period window as before). Results from this specification, reported in Column (2) of Table 2, show that the sharper widening in spreads of US dollar-denominated bonds is robust to this tighter specification. The magnitude of the estimated coefficient is in line with the cross-sectional specification, taking into account that specification 2 is estimated using daily spread changes over a period of 16 business days – thus leading to an average increase in spreads of dollar bonds relative to non-dollar bonds of about 120 basis points in the period from February 28th to March 20th.

How did the dash for dollars evolve over time? We further leverage the daily nature of the data to provide a finer analysis of different phases of the crisis. For this purpose, we estimate the following specification:

$$\Delta s_{b,it} = \alpha + \alpha_{i,t} + \alpha_w \cdot \beta_1 USD_{b,i} + \Gamma X_{b,i} + \varepsilon_{b,it} \quad (3)$$

where the only difference relative to specification (2) is the presence of α_w, a week fixed effect that allows us to capture the evolution of β_1 over time (on average, by week). The results from this specification are reported in Figure 2. The figure shows that pressure on US dollar spreads was cumulative, building up up to the announcement of targeted measures by the Fed on March 23rd.

Figure 2 The Dash for Dollars over time



Note. Time-varying (weekly) estimates of the differential increase in spreads of dollar-denominated bonds vis-a-vis non-dollar bonds using a within-firm specification (3) with firm-day fixed effects.

2.3 Mechanisms

What does the empirical evidence around this dimension of heterogeneity tell us about the nature of the shock and its transmission mechanism? In a tail event such as the one induced by the Covid-19 shock, investors require cash to meet margin calls, redemptions, and other immediate obligations (either as a realization or in expectation), thus generating a dash for cash (see Haddad et al., 2021, among others). The pattern we document — that dollar bonds experienced larger price drops than non-dollar bonds — suggests that investors in need of cash sold their dollar-denominated assets first. We put forward two non-mutually exclusive interpretations that can explain our findings, both of which are ultimately related to the role of the US dollar as the dominant currency in the international monetary and financial system.[9]

Liquidity The first one is the dollar's superior liquidity, stemming from its dominant role as a medium of exchange. Eichengreen and Xia (2019) document that the dollar serves as the undisputed vehicle currency for international debt issuance, cross border loans, FX turnover and reserve accumulation. As discussed, among others, by Gourinchas et al. (2019), the widespread use of the US dollar is in part a consequence of its liquidity, i.e. the fact that large transactions can be conducted without a material impact on prices.

In response to a liquidity shock, investors often following a pecking order of liquidity, selling their most liquid assets first in order to minimize the adverse price impact of their fire sales. Theory and evidence for this type of response are abundant in the literature – e.g. Chernenko and Sunderam (2016), Moreira and Savov (2017), Haddad et al. (2021), Ma et al. (2022). If intermediaries do not have the capacity or willingness to absorb the resulting increase in supply, such selling pressure can lead to larger falls in prices (increases in spreads) of more liquid securities compared to less liquid ones. This mechanism can therefore help rationalize the results in Table 2, as long as investors perceive US dollar bonds as more liquid than non-dollar bonds.

Balance sheets The second dimension is related to the use of the US dollar as a unit of account. One aspect of this property is the widespread denomination of financial and real liabilities in US dollars, which means that agents need to secure US dollars when these liabilities become due, including during periods of stress (for example to meet margin calls, investor redemptions, etc). The resulting selling pressure can, once more, lead to downward pressure on prices if intermediaries do not have the capacity or willingness to absorb the additional supply.

[9] A growing literature has documented the hegemony of the US dollar for both goods and assets markets. Goldberg and Tille (2008) and Gopinath (2016) provide evidence on the extensive use of the dollar for trade invoicing. Ilzetzki et al. (2019) document the dominant role of the dollar as an anchor currency. It is also well known that banks and non-banks outside the US tend to borrow in US dollars (see, among many others, Shin, 2012; Brauning and Ivashina, 2020) and to invest in US dollar assets (Maggiori et al., 2020).

The liquidity-based interpretation, thus, is not the only possible reading of our results. A complementary hypothesis is that investors did not sell dollar assets because of their superior liquidity, but because of an increase in the likelihood of having to meet dollar-denominated liabilities. Of course, investors could also obtain US dollar 'synthetically' by selling non-dollar assets and hedging the resulting exchange rate risk in FX markets. Historical evidence shows, however, that the cost of this operation — as captured by deviations in the Covered Interest Parity (CIP) condition — tends to increase during periods of stress, and the Covid-19 episode was not an exception.[10] Our second hypothesis is therefore that investors did not only require cash in general, but US dollar cash in particular, and that they were forced to sell US dollar assets to secure it.[11]

In Section 4, we exploit information from a granular, regulatory transaction-level data set, maintained by the UK's Financial Conduct Authority (FCA), to shed light on the relevance of the two channels described above. Before that, however, Section 3 provides some additional evidence on the robustness of our main result that dollar-denominated bonds experienced a larger increase in credit spreads relative to non-dollar bonds during the Covid market turmoil.

3 Identification Challenges & Robustness

The main advantage of our data set is the fact that companies tend to issue a large number of bonds in a range of currencies. As discussed above, this means we can identify the role of the issuance currency in explaining the heterogeneity in spread dynamics using within-firm

[10] Avdjiev et al. (2020); Bahaj et al. (2020); Eren et al. (2020) among others provide extensive evidence on the widening of CIP deviations during the Covid-19 episode. See Figure D.1 in Appendix D.

[11] A third interpretation is that selling pressure affecting US dollar bonds could have originated in investors revising down their expectations for the future path of the US dollar after its sharp appreciation in March 2020. However, it is hard to believe that in a context of heightened market tensions and high levels of risk aversion investors would have chosen an asset class with such high transaction costs and low liquidity as corporate bonds to execute trades reflecting this view. Additionally, paths implied by FX forwards, despite being an imperfect measure of expectations, point to *improved* prospects for the US dollar during our window (see Figure D.2 in Appendix D).

variation—that is, keeping firms' characteristics fixed. There are, however, a number of identification challenges that complicate our task.

First, there may be other bond characteristics that are correlated with the currency of denomination. For example, if dollar bonds have systematically shorter maturities than non-dollar bonds, our specification could be wrongly assigning the effect of the bond's maturity to the currency of denomination.

Second, firm fixed effects do not ensure that identification comes exclusively from within-firm information. The fixed effects absorb the average spread variation for each firm, but the remaining across-firms heterogeneity is still used to obtain the coefficient estimates. Moreover, as our sample includes bonds issued by firms headquartered in many countries around the world, and regulation and balance sheet practices of these firms may be heterogeneous, there is a risk that the patterns we document are not truly global, but specific to a particular geography.

Third, given the unique episode we consider (namely, the financial turmoil induced by the Covid-19 pandemic), it is not obvious that the dynamics we uncover are common to other crisis episodes. At the same time, we may be picking up a permanent feature of international bond markets that has nothing to do with crisis episodes.

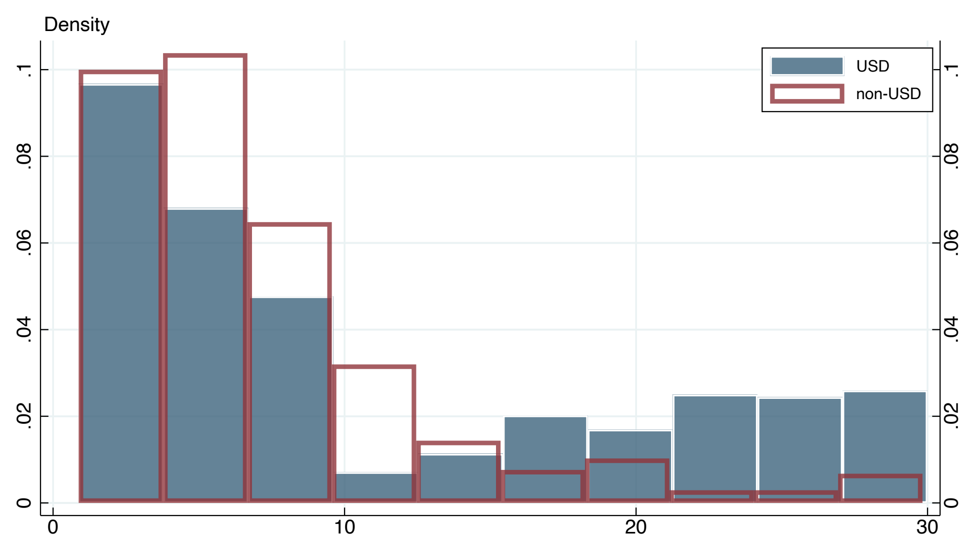
In this section, we conduct a number of exercises that address the identification challenges outlined above and provide additional evidence for the robustness of our main result.

3.1 The Role of Bond Maturity

A bond's maturity and its currency of denomination both vary within-firm and could be related to each other. If this were to be the case, our interpretation of the empirical findings could be confounded by the role of maturity in explaining spread dynamics during the Covid-19 crisis. This concern is particularly important given the existing evidence that more liquid, shorter-term bonds experienced larger falls in prices than long-term bonds (among others Haddad et al., 2021).

We address this concern by exploring the empirical relation between maturity and currency of issuance. Figure 3 plots the distribution of bond maturity for dollar-denominated and non-dollar bonds in our sample. It shows that dollar bonds tend to have longer maturities than non-dollar bonds. Specifically, the average and median maturity is 11 and 7 years for dollar bonds; and 7 and 6 years for non-dollar bonds. This unconditional analysis of the data is reassuring: if the mechanism highlighted by Haddad et al. (2021) was also present in our sample — with short-term bonds experiencing larger price falls than long-term ones — the omission of maturity in our baseline specification in Section 2 would, if anything, result in an attenuation bias for the role of the US dollar.

Figure 3 Distribution of Bond Maturity by Currency



Note. Distribution of bond maturity for dollar-denominated and non-dollar bonds in our sample. Average and median maturity is 11 and 7 years for dollar bonds; and 7 and 6 years for non-dollar bonds. The horizontal axis is in years.

A more formal exercise can help to shed some light on the separate effects of maturity and currency of denomination on bond spreads. Specifically, we estimate the following specification:

$$\Delta s_{b,it} = \alpha + \alpha_{it} + \beta_1 USD_{b,i} + \beta_2 Matu_{b,it} + \beta_3 \left(USD_{b,i} \cdot Matu_{b,it} \right) + \Gamma X_{b,i} + \varepsilon_{b,it} \qquad (4)$$

where $Matu_{b,it}$ is the maturity of bond b issued by firm i, and all other variables are the same as in our baseline specification (2).

The results are reported in Table 3. For ease of comparison, Column (1) reports the coefficient of the dollar indicator variable alone, as in our baseline specification in Table 2. Column (2) reports the estimated coefficient of $Matu_{b,it}$, which is statistically not different from zero. This stands in contrast to the logic of the liquidity pecking order, according to which more liquid short-term bonds should experience a larger increase in spreads, thus leading to a negative estimate of β_2. Consistent with the unconditional evidence in Figure 3, however, this result may be confounded by the correlation between currency of issuance and maturity. Column (3), which considers the currency and maturity dimensions jointly, shows that the coefficient on maturity becomes negative and statistically significant; that is, shorter maturity bonds indeed experience a larger increase in spreads, in line with the findings in Haddad et al. (2021). Importantly, the coefficient on the dollar indicator variable remains significant and the magnitude actually becomes slightly larger in comparison to our baseline results.

In a final exercise, we ask whether the maturity and currency dimensions uncovered in Columns (1) to (3) in Table 3 are related or independent. We tackle this question by incorporating an interaction term between bond maturity and the US dollar indicator variable ($USD_{b,i} \cdot Matu_{b,it}$). The results from this specification are reported in Column (4) of Table 3.

We highlight three results. First, US dollar spreads increase by more than the spreads of bonds denominated in other currencies (independent of the maturity), as shown by the positive sign of the coefficient on the dollar indicator variable (β_1). Second, within the group

Table 3 Bond Spreads Widening: The Role of Currency and Maturity

	(1)	(2)	(3)	(4)
US dollar (β_1)	7.54***		7.84***	10.44***
	(2.55)		(2.56)	(3.10)
Maturity (β_2)		0.04	-0.11**	0.19*
		(0.06)	(0.05)	(0.11)
US dollar × Maturity (β_3)				-0.34***
				(0.11)
Observations	50685	50685	50685	50685
R^2	0.355	0.350	0.356	0.356
Number of Firms	225	225	225	225
Firm FE	no	no	no	no
Firm-Time FE	yes	yes	yes	yes
Double clustering	yes	yes	yes	yes

Note. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Coefficients corresponding to the constant, fixed effects, level of credit spread at the beginning of the sample, coupon type dummies, amortization type dummies, and bond face value not reported.

of dollar bonds, shorter maturity bonds are associated with a larger increase in spreads, as indicated by the negative coefficient of the interaction term (β_3)—and consistent with the findings (and interpretation) in previous studies that focused on US data. Third and finally, longer maturity bonds experience larger increases in spreads in the non-dollar sample, as shown by the positive sign of the coefficient on maturity (β_2). The reversal in the relation between maturity and bond spreads in the non-dollar sample suggests that the pecking order of liquidity mechanism is not the dominant channel, as one would expect more liquid short-term bonds to be subject to a larger selling pressure (i.e. a larger increase in spreads) for each currency in isolation.

3.2 Strengthening the Within-firm Identification

To increase the relative importance of within-firm information in the identification of our baseline effect, we take the within-firm argument to the limit and estimate our baseline specification on a firm-by-firm basis—i.e. by exploiting information across a given firm's outstanding bonds. This exercise is made possible by the fact that some firms in our sample have a large number of outstanding bonds (for example, our sample contains data on 92 different bonds issued by AT&T).

Table 4 Bond Spreads Widening: Firm-level Regressions

	(1) British Pet.	(2) AT&T	(3) Toyota	(4) Walmart	(5) Vodafone	(6) Mc Donald's
US dollar (β_1)	16.75*	18.10***	8.46***	6.08*	15.16**	15.64***
	(8.53)	(2.79)	(2.72)	(3.65)	(6.78)	(4.47)
Maturity (β_2)	-1.44	0.12	0.91	0.06	0.45	0.59
	(2.18)	(0.26)	(0.95)	(0.18)	(0.37)	(0.55)
US dollar × Maturity (β_3)	-2.08	-0.64***	-1.46	-0.17	-0.54**	-0.78**
	(1.57)	(0.18)	(1.00)	(0.24)	(0.25)	(0.33)
Observations	630	1582	595	612	595	647
R^2	0.040	0.037	0.024	0.003	0.076	0.034
Number of Bonds	38	96	37	36	35	39
Firm FE	no	no	no	no	no	no
Firm-Time FE	no	no	no	no	no	no
Double clustering	no	no	no	no	no	no

Note. Robust standard errors are reported in parentheses. *** p¡0.01, ** p¡0.05, * p¡0.1. Coefficients corresponding to the constant, level of credit spread at the beginning of the sample, coupon type dummies, amortization type dummies, and bond face value not reported.

Table 4 reports the coefficient estimates for a selected set of individual firms ranked by the number of their bonds outstanding, while still meeting the multi-currency requirement. The results are in line with our baseline specification. Specifically, we find that US dollar bonds experienced a larger increase in spreads, independent of their maturity, as evident from the positive and significant estimates of β_1 for all firms.

3.3 Geographical Heterogeneity

One potential concern about our baseline results in Table 2 is that they might not be truly global in nature, but may instead reflect particular dynamics in a given geography. This could arise, for example, due to heterogeneity in regulations or balance sheet practices across different jurisdictions. To address this concern, and assess the robustness of our baseline results, we again use specification (4) and split our sample into different groups of countries.

Table 5 Bond Spreads Widening: Geographical splits

	(1) US	(2) non-US	(3) Advanced Ec.	(4) Advanced Ec. excl. US	(5) Euro
US dollar (β_1)	11.55***	9.70***	10.48***	9.01***	8.47***
	(3.50)	(2.90)	(3.17)	(2.72)	(2.68)
Maturity (β_2)	0.17	0.20	0.12	0.05	0.07
	(0.14)	(0.13)	(0.10)	(0.08)	(0.04)
US dollar × Maturity (β_3)	-0.38***	-0.33*	-0.32**	-0.28*	-0.28***
	(0.12)	(0.16)	(0.11)	(0.15)	(0.10)
Observations	28565	22119	47946	19380	9753
R^2	0.339	0.396	0.334	0.318	0.228
Number of Firms	108	121	206	102	45
Firm FE	no	no	no	no	no
Firm-Time FE	yes	yes	yes	yes	yes
Double clustering	yes	yes	yes	yes	yes

Note. Robust standard errors are reported in parentheses. *** p¡0.01, ** p¡0.05, * p¡0.1. Coefficients corresponding to the constant, level of credit spread at the beginning of the sample, coupon type dummies, amortization type dummies, and bond face value not reported.

Table 5 reports the results from this exercise. It shows that our benchmark results hold for samples of (i) advanced economies, (ii) US, (iii) non-US, (iv) advanced economies ex-US and (v) European Union headquartered firms. More precisely, the dollar-denomination is a central variable for understanding the spread dynamics of corporate bonds issued by companies both inside and outside the United States.

3.4 Dynamics During the Global Financial Crisis

The fact that corporate bond spreads displayed dynamics consistent with a dash for dollars during the peak of the Covid-19 market turmoil leads to the natural question whether this phenomenon is common to other crisis episodes. In this section, we explore the behavior of corporate bond spreads in the second half of 2008, at the height of the Global Financial Crisis (GFC), to assess whether the patterns uncovered in Section 2 also hold in that period.

In particular, we estimate specification (4) for a sample of corporate bonds comprising the same index used in our baseline results (i.e. investment grade bonds comprising the ICE Bank of America Merrill Lynch's Global Corporate Index).[12] We consider the change in spreads between June 16 (a local minimum for the Global Corporate Index, which precedes the sharpest acceleration on record) and December 8th (the all-time peak of the index). This period therefore covers the filing for bankruptcy of Lehman Brothers in September 2008, a usual reference point for analyzing GFC-related dynamics.

Our results, reported in Table 6, show that it was indeed US dollar-denominated bonds, particularly those of shorter maturities, that displayed the largest widening in spreads during the height of the GFC, as it was the case during the Covid-19 market turmoil. Differently from the Covid-19 episode, results do not point to a stronger widening in spreads at longer maturities for non-US dollar bonds, at least in a statistically significant way. Importantly, however, they do not point to a sharper widening for shorter maturities either, as it is the case for US dollar bonds. In terms of magnitudes, the coefficients are similar in size to those reported in Table 2, but are smaller in relative terms given the sharper increase in overall spreads in 2008: the intercept for the GFC exercise is more than twice as large than the one for the Covid-19 period. Also, the combination of currency of denomination and maturity explains a smaller share of the overall variation in spreads in the GFC period compared to the Covid-19 one: the R^2 of our preferred specification, reported in column (4) in both tables, is 19% for GFC and 26% for Covid-19.

These results reinforce our interpretation that, during periods of stress, investors try to

[12] Naturally, the overlap between the GFC and the Covid-19 samples is only partial due to the issuance of new bonds and the maturing of existing bonds. Despite the difference in the constituents, we note that the characteristics of the bonds considered for the exercise in this section are very similar to our baseline as reported in Section A. See Tables B.1 and B.2 in Appendix B.

Table 6 BOND SPREADS WIDENING: GLOBAL FINANCIAL CRISIS

	(1)	(2)	(3)	(4)
Maturity (β_1)	-2.89***		-3.17***	0.39
	(0.38)		(0.39)	(0.58)
USD (β_2)		141.60***	149.28***	190.40***
		(19.81)	(19.82)	(23.57)
USD x Maturity (β_3)				-4.37***
				(0.80)
Constant	358.51***	239.38***	268.85***	236.53***
	(4.31)	(12.32)	(11.97)	(14.30)
Observations	3,658	3,658	3,658	3,658
R-squared	0.06	0.11	0.17	0.19
Number of firms	847	847	847	847

NOTE. Columns (1) to (3) report results from specification (1), namely $\Delta s_{b,i} = \alpha + \delta_i + \beta_1 Matu_{b,i} + \beta_2 USD_{b,i} + \Gamma X_{b,i} + \varepsilon_{b,i}$. Column (4) reports results from specification (4), namely $\Delta s_{b,i} = \alpha + \delta_i + \beta_1 Matu_{b,i} + \beta_2 USD_{b,i} + \beta_3 Matu_{b,i} \times USD_{b,i} + \Gamma X_{b,i} + \varepsilon_{b,i}$. Robust standard errors are reported in parentheses. Credit spread changes between 8th December and 16th June 2008 (dependent variable) are trimmed at the 1st and 99th percentiles. *** p<0.01, ** p<0.05, * p<0.1. Coefficients corresponding to coupon type dummies and bond face value not reported.

secure US dollars in particular, rather than cash in general. As discussed in Section 2, we link this interpretation to the role of the US dollar as the dominant global currency—and, in particular, to its role as an international medium of exchange and unit of account. Moreover, the stronger effects seen during the Covid-19 pandemic compared to the GFC in 2008 (in terms of relative magnitude and share of variance explained) could reflect the increasing dominance of the US dollar, as documented by Maggiori et al. (2020).

4 Inspecting the Mechanism

Having established that US dollar-denominated bonds experienced a larger increase in spreads than counterparts in other currencies during the Covid-19 market turmoil, we now turn to inspecting the underlying mechanisms behind such price dynamics. First, we use regulatory bond transaction data to provide evidence that the fall in prices is indeed contemporaneous to investors' pronounced selling pressure. We then assess the importance and interconnectedness of two potential channels at play — namely, dollar bonds' superior liquidity and the dollar's international role as the main currency of denomination of financial and real liabilities.

4.1 Dollar Bond Selling Pressure

In order to conduct the exercises in this section we exploit data from the transaction-level MiFID II database, which is maintained by the UK's Financial Conduct Authority (FCA). The MiFID II data provide detailed reports of all secondary-market trades meeting one of the following conditions: i) trades carried out on a UK trading venue, ii) trades in a FCA-regulated instrument on a venue in the European Union (up until 31 December 2020), and iii) trades where at least one counterparty is an FCA-regulated entity. Each transaction report contains information on the transaction date and time, ISIN, execution price, transaction size, and the legal identities of the buyer and seller.[13] The sample covers the period from January 2018 to May 2020, and we obtain information on $\sim$ 2.1m trades in 7.4k corporate bonds. As in the previous analysis, we exclude financial bonds, and we focus on dealer-client trades.[14] We merge our transaction-level data with information on bond characteristics (issuer, rating, etc.) from S&P Capital IQ.

We also collect granular supervisory data on the derivative holdings of insurance companies regulated by the UK's Prudential Regulation Authority (PRA) and subject to the Solvency II Directive. Insurers within scope of the Solvency II Directive are required to submit annual and quarterly returns, with the exception of some smaller firms with quarterly waivers. In total, we observe the derivative holdings of 79 UK insurers. The reports include detailed information on the holdings of a given insurer, such as the identity of the counterparty, underlying security, notional amount, derivative category (e.g. FX forward),

[13] We allocate investors to an investor group (e.g. hedge funds) using a best-endeavor sectoral classification, which is naturally subject to uncertainties (e.g. allocation of insurer with asset management arm).

[14] Dealers tend to have distinctive motives for trading in the interdealer market (e.g. for re-balancing of inventories), and we therefore exclude these trades from our sample.

and swap delivered/received currencies.

In terms of the exercises conducted, we begin by documenting the existence of selling pressure affecting US dollar bonds, which in the previous sections was put forward as the main hypothesis behind the marked fall in their prices. In particular, we use our rich regulatory data set to run the following within-investor-issuer specification:

$$NetVol_{b,ijt} = \alpha + \alpha_{ijt} + \beta_1 USD_b + \Gamma X_{b,it} + \varepsilon_{b,ijt} \tag{5}$$

where $NetVol_{b,ijt}$ is investor j's daily net trading volume (in terms of quantities) of bond b issued by firm i; α is a constant; α_{ijt} is a issuer-investor-day fixed effect; USD_b is a dummy variable for USD-denominated bonds; and $X_{b,i}$ are a set of additional controls which include the bond's time-to-maturity and time-since-issuance. We are therefore able to compare the trades of the same investor, on the same day, across bonds of the same issuer. As before, we focus on the period between February 28th and March 20th. Furthermore, we also run regressions separately for investors' buy and sell volumes, depending on whether investor j was a net buyer or net seller of bond b on a given day. We cluster standard errors at the issuer level.

The results, reported in Table 7, show that investors' net trading volumes are significantly lower for dollar bonds compared to non-dollar bonds. This effect is particularly pronounced for investment grade bonds, while it is absent in our sample of high yield bonds. Importantly, we find that the lower net trading volumes are driven by investors' higher sales of dollar bonds, rather than by lower purchases of dollar bonds. That is, there is strong evidence that the pronounced fall in US dollar bond prices was indeed linked to investors' selling pressure.

To investigate the timing of this pattern in more detail we repeat the estimation using weekly dummy variables interacted with the US dollar dummy, as already done in Section

2 in the context of analyzing price dynamics. The coefficients from this interaction are reported in Figure 4, which shows that investors' net trading volumes in dollar bonds were indistinguishable from trading volumes in non-dollar bonds during the build-up of the Covid-19 crisis, i.e. in late February / early March 2020. However, starting in the week ending March 13, investors started to sell dollar bonds in significantly higher quantities than non-dollar bonds. The results therefore emphasize the pronounced selling pressure in dollar bonds during the peak of the Covid-19 market turmoil, particularly in the safer and more liquid investment grade segment of the market (consistent with evidence in, for example, Haddad et al., 2021).

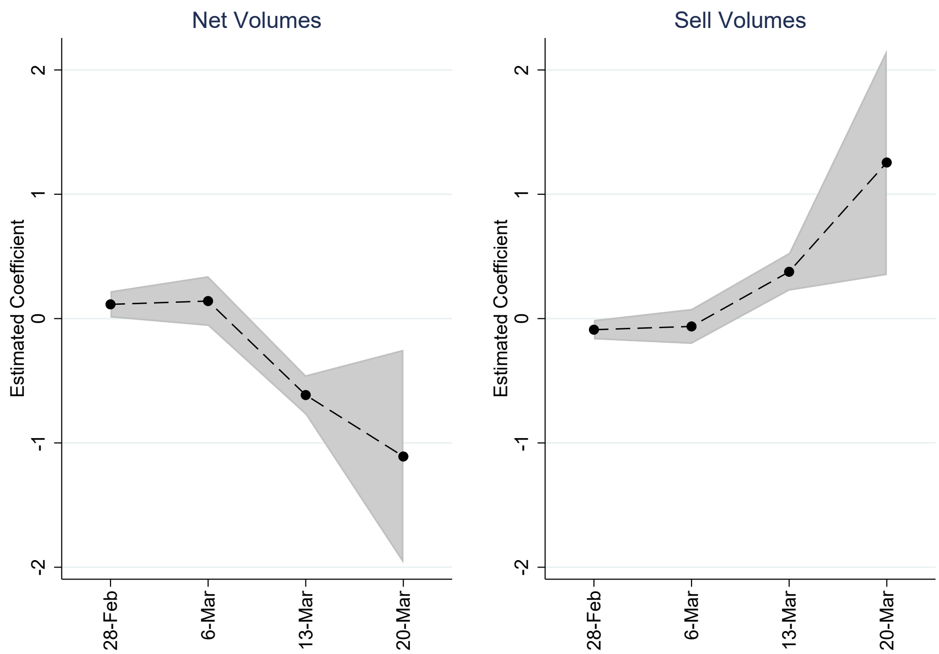
Table 7 CORPORATE BOND TRADING VOLUMES

	(1) Net Volume	(2) IG Only	(3) HY Only	(4) Buy Volume	(5) Sell Volume
US dollar (β_1)	0.21**	-0.61***	-0.10	0.01	0.22***
	(0.09)	(0.07)	(0.13)	(0.03)	(0.07)
Investor x Day x Issuer FE	Yes	Yes	Yes	Yes	Yes
Observations	3000	1444	903	3000	3000
R-squared	0.725	0.770	0.477	0.788	0.704

NOTE. Results from specification (5). Net volumes (in millions) are measured on the investor-day-bond level in the period between February 28th and March 20th. Buy (Sell) volume is equal to net volume if the given investor is a net buyer (seller) of bond b on day t, and zero otherwise. Robust standard errors clustered on the issuer level are reported in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Coefficients corresponding to the constant, control variables and fixed effects not reported.

Next, we examine whether the selling pressure is concentrated in a particular client sector. In Figure A.2 in the appendix, we show that the insurance & pension fund (ICPF) sector was the main net seller of dollar bonds ($\sim$ 700m) in the UK corporate bond market during Covid-19, potentially driven by the large VM calls on ICPFs' FX hedging positions (see Czech et al., 2021). For a more robust test, we use a variant of our within-investor-issuer regression model (5), and we interact *DollarBond* with indicator variables for the different investor types in our sample. The results are presented in Table 8. We find that the dollar bond selling pressure is largely concentrated in the ICPF sector, consistent with Figure A.2. While the effect is statistically highly significant for ICPFs, we find no statistical significance for any of the other investor types. As discussed in more detail below, a potential driver

Figure 4 Net Trading Volumes during Covid-19: Dollar vs. Non-dollar



Note. The figure shows the difference in investors' net trading volumes between dollar bonds and non-dollar bonds, using the following specification with weekly fixed effects: $NetVol_{b,ijt} = \alpha + \alpha_{ijt} + \alpha_w \times \beta_1 USD_b + \Gamma X_{b,it} + \varepsilon_{b,ijt}$. The net trading volumes are measured on the investor-bond-day level. The 95% confidence interval (in gray) is calculated based on robust standard errors clustered on the issuer level.

for ICPFs' pronounced selling of dollar bonds could be the pressure to obtain dollar cash to meet VM calls on their dollar-denominated derivative contracts, which account for a large share of insurers' total derivative holdings ($\sim$ 20%, see Figure A.3).

Having reported robust evidence of selling pressure affecting US dollar bonds, we now turn to studying potential mechanisms that could be behind these dynamics.

4.2 Liquidity Inversion

Having established that US dollar corporate bonds experienced more pronounced selling pressure than counterparts in other currencies at the height of the Covid-19 financial tur-

Table 8 Corporate bond trading volumes by Sector

	(1)	(2)	(3)	(4)	(5)
	Net Volume in COVID Period				
Dollar Bond	-0.20**	-0.20**	-0.24*	-0.21**	-0.21
	(0.10)	(0.09)	(0.14)	(0.09)	(0.16)
Dollar Bond × ICPF	-1.05***				-1.04***
	(0.17)				(0.20)
Dollar Bond × Non-Dealer		-0.07			-0.05
		(0.08)			(0.08)
Dollar Bond × Asset Manager			0.12		0.09
			(0.19)		(0.21)
Dollar Bond × Hedge Fund				-0.09	-0.09
				(0.06)	(0.12)
Investor x Day x Issuer FE	Yes	Yes	Yes	Yes	Yes
Observations	3000	3000	3000	3000	3000
R-squared	0.725	0.725	0.725	0.725	0.725

Note. Results from a variant of specification (5). Net volumes (in millions) are measured on the investor-day-bond level in the period between February 28th and March 20th. Buy (Sell) volume is equal to net volume if the given investor is a net buyer (seller) of bond b on day t, and zero otherwise. "ICPF", "Non-Dealer", "Asset Manager" and "Hedge Fund" are indicator variables for the corresponding investor types. Robust standard errors clustered on the issuer level are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Coefficients corresponding to the constant, control variables and fixed effects not reported.

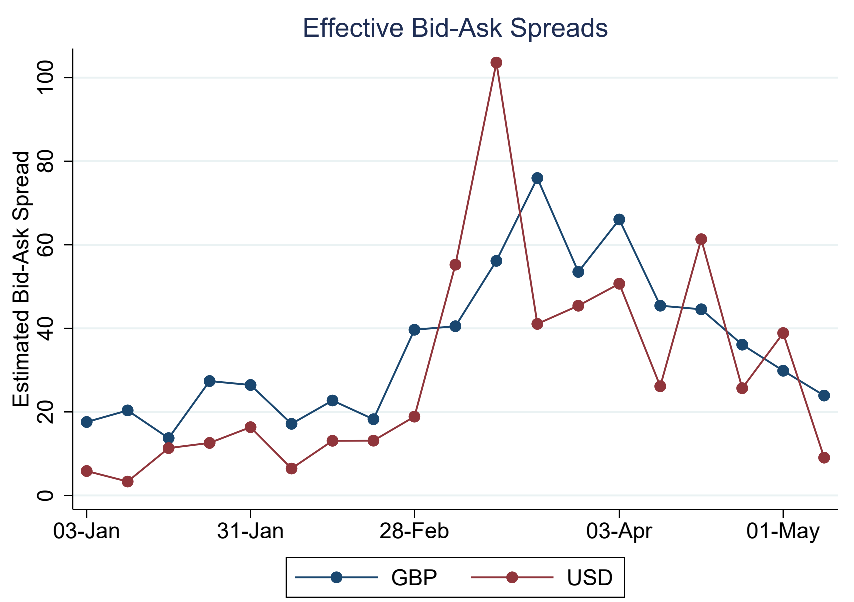
moil, we now put forward two possible (non mutually-exclusive) mechanisms behind these dynamics. Both of these mechanisms are ultimately related to the dominant role of the US dollar in the international monetary and financial system.

The first mechanism, which is related to the dollar's role as a 'dominant' medium of exchange, puts emphasis on the superior liquidity of dollar bonds. According to this hypothesis, and considering that the selling costs of dollar bonds should be expected to be lower than those of bonds denominated in other currencies given the mentioned superior liquidity, investors in need of cash would have an incentive to liquidate their dollar bonds first in order to minimize fire-sales losses. This behavior would imply investors follow a 'pecking order of liquidity', which has been documented in other contexts. Consistent with this view, Figure 5 suggests that the effective bid-ask spreads of dollar bonds were indeed substantially lower than those of pound sterling bonds during the immediate pre-Covid period (January

- February 2020).[15]

While individual investors could have decided to sell US dollar bonds first because of their superior liquidity, the aggregate consequence of such actions seem to have resulted in a negation of the initial premise: Figure 5 suggests a "liquidity inversion" at the height of the Covid tensions, as average bid-ask spreads of investment grade dollar bonds increased significantly more than sterling counterparts. This is consistent with the evidence in Haddad et al. (2021) and Ma et al. (2022), who show that more liquid assets experienced larger price discounts than their more illiquid counterparts.

Figure 5 Effective bid-ask spread levels: Dollar vs. Pound sterling



Note. The figure shows the average weekly level of effective bid-ask spreads for dollar bonds and pound sterling bonds. The effective bid-ask spreads are measured on the bond-day level and defined as twice the difference between the trade price and the bid/ask midpoint.

To test for this "liquidity inversion" hypothesis more formally, we compare effective bid-ask spreads of dollar vis-à-vis non-dollar bonds during the Covid-19 market turmoil by

[15]In Table A.4 in the appendix, we use within-issuer regressions to provide evidence of the superior liquidity of dollar bonds using our entire pre-Covid-19 sample period (Jan 2018 - Feb 2020).

estimating the following within-firm specification:

$$BidAsk_{b,it} = \alpha + \alpha_{it} + \beta_1 USD_b + \Gamma X_{b,it} + \varepsilon_{b,it} \tag{6}$$

where $BidAsk_{b,it}$ is the effective bid-ask spread of bond b issued by firm i, which is defined as twice the difference between the trade price and the bid/ask midpoint (the midpoint is viewed as a proxy for the fundamental value of the asset). Moreover, α_{it} is an issuer-day fixed effect; and the remaining variables are defined in the same way as in specification (5). We thus compare the daily bid-ask spreads of dollar bonds vs. non-dollar bonds issued by the same firm.

The results are shown in Table 9 and Figure 6 below. We find that — for the same issuer and on the same day — bid-ask spreads were significantly higher for dollar bonds compared to non-dollar bonds during the Covid-19 crisis. The economic magnitude is large: dollar bonds' effective bid-ask spreads were on average 15 basis points higher than those of non-dollar bonds during the Covid-19 crisis (Column 2 of Table 9), and even 32 basis points higher in the case of investment grade bonds (Column 4). Importantly, we find no significant difference in bid-ask spreads between dollar and non-dollar bonds in the case of high-yield bonds, hence highlighting that the "liquidity inversion" did not occur in this riskier and less liquid segment of the corporate bond market.

Figure 6 shows the weekly variation of the within-issuer difference in effective bid-ask spreads between dollar bonds and non-dollar bonds for both investment grade bonds and high yield bonds. In the case of investment grade bonds, we find that the difference in effective bid-ask spreads of dollar bonds vis-à-vis non-dollar bonds started to widen in early March and reached its peak in the week ending March 13 (at around 80 basis points), before it started to close again towards the end of March. However, in the case of high yield bonds, we find that the difference in effective bid-ask spreads of dollar bonds vs. non-dollar bonds was indistinguishable from zero throughout the entire crisis period.

Table 9 Effective bid-ask spreads during Covid-19

	(1)	(2)	(3)	(4)	(5)	(6)
	Whole Sample		IG Only		HY Only	
Dollar Bond	20.89***	14.63*	32.40***	35.69***	10.15	-2.13
	(7.12)	(7.42)	(6.77)	(4.20)	(6.58)	(2.68)
Day FE	Yes	/	Yes	/	Yes	/
Issuer FE	Yes	/	Yes	/	Yes	/
Day × Issuer FE	No	Yes	No	Yes	No	Yes
Observations	1063	665	502	327	366	239
R-squared	0.214	0.410	0.287	0.436	0.158	0.465

Note. Results from specification (6). The effective bid-ask spreads are measured on the bond-day level and defined as twice the difference between the trade price and the bid/ask midpoint. We focus on the period between February 28th and March 20th. Robust standard errors clustered on the issuer level are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Coefficients corresponding to the constant, control variables and fixed effects not reported.

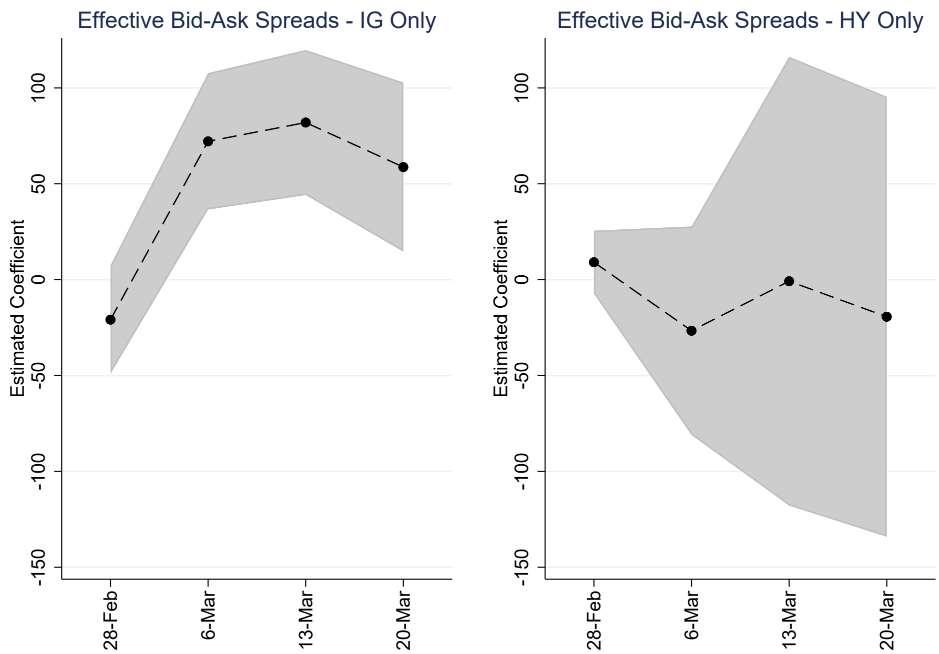
In sum, there is evidence that, while selling pressure affecting US dollar bonds could have been driven by an ex-ante perceived superior liquidity of these vis-a-vis non-dollar alternatives, the externalities resulting from these actions contributed to increase the liquidation cost of these bonds during the height of the Covid-related tensions.

4.3 Dollar Liabilities

While it is plausible that the perceived ex-ante superior liquidity of US dollar bonds could have been the initial driver of the selling pressure affecting these securities if investors follow a liquidity pecking order and sell their more liquid bonds first (see, e.g., Ma et al., 2022; Haddad et al., 2021), it seems less likely that investors did not account for price distortions (e.g. systematically higher bid-ask spreads of dollar bonds) in real time. Therefore, there is room for alternative, complementary forces driving the selling pressure affecting US dollar bonds.

Consistent with this view, we put forward a second mechanism that is related to the dollar's role as 'dominant' unit of account given the prevalence of dollar-denominated funding. According to this view, selling pressure affecting US dollar bonds could have been driven by investors' need to secure US dollar cash to meet dollar-denominated obligations. In 'normal'

Figure 6 Effective bid-ask spreads: Dollar vs. Non-dollar (within-issuer)



Note. The figure shows the difference in effective bid-ask spreads between dollar bonds and non-dollar bonds, using the following specification with weekly fixed effects: $BidAsk_{b,t} = \alpha + \alpha_{j,t} + \alpha_{w\times}\beta_1 USD_b + \Gamma X_{b,it} + \varepsilon_{b,t}$. The left panel shows the coefficients for the investment grade bond sample, while the right panel shows the coefficients for the high yield bond sample. The effective bid-ask spreads are measured on the bond-day level and defined as twice the difference between the trade price and the bid/ask midpoint. The 95% confidence interval (in gray) is calculated based on robust standard errors clustered on the issuer and day level.

times these dollars could have of course been secured by selling non-dollar securities and hedging the resulting FX mismatch, but the cost of this operation, as measured by deviations in the covered interest rate parity condition, were abnormally high during the financial tensions arising from the expansion of Covid-19 (Avdjiev et al., 2020; Bahaj and Reis, 2020).

To test for the relevance of this potential complementary mechanism, we exploit a particular feature of the Covid-19 crisis, namely that UK insurers were in need of abnormally large quantities of cash due to huge variation margin (VM) calls on their FX hedging positions (Czech et al., 2021). Importantly, investors are typically required to meet VM calls in the contract currency — and we therefore expect higher dollar bond selling pressure by investors with a larger share of dollar-denominated derivative contracts. If the the need to secure dolalrs to meet dollar-denominated obligations was behind the selling pressure affecting US dollar securities, then we would expect this selling to be particularly high by investors facing larger cash needs arising from dollar-denominated liabilities.

We formalise this idea by estimating the following specification:

$$NetVol_{b,ijt} = \alpha + \alpha_b + \alpha_j + \alpha_{it} + \beta_1 USD_b \times DollarShare_j + \varepsilon_{b,ijt} \tag{7}$$

where $DollarShare_j$ measures the share of dollar-denominated derivative contracts of investor j at the end of Q4 2019; and the remaining variables are defined in the same way as in specification (5). To facilitate the interpretation of the coefficients, we transform $DollarShare_j$ by subtracting the cross-sectional average, before dividing it by the standard deviation. In an alternative specification, we divide the sample of investors into below-average and above-average holders of USD derivative contracts, using the sample median as the cut-off point.

The results are reported in Table 10. We find that investors with a higher share of dollar-denominated derivative contracts had substantially lower net trading volumes in dollar bonds compared to non-dollar bonds. In other words, UK insurers likely sold dollar bonds to meet dollar-denominated VM calls during the Covid-19 market turmoil. Importantly, this result is statistically highly significant and robust to the inclusion of various fixed effects, which control for a range of unobserved time-invariant and time-varying factors. Therefore, the results lend strong support to the hypothesis that investors sold dollar assets to meet dollar obligations.

A potential concern is that these results may simply reflect a mechanical portfolio re-balancing of UK insurers, i.e. a shift towards non-dollar assets to bring the share of dollar assets back to an initial target, following the sharp appreciation of the dollar during the

Table 10 USD DERIVATIVE CONTRACTS AND BOND VOLUMES

	(1)	(2)	(3)	(4)
	Net Volume in COVID Period			
Dollar Bond x Dollar Share	-17.54***	-25.95**		
	(2.96)	(9.64)		
Dollar Bond x High Share			-6.26***	-9.26**
			(1.05)	(3.44)
Investor FE	Yes	Yes	Yes	Yes
Bond FE	Yes	Yes	Yes	Yes
Day FE	Yes	/	Yes	/
Day x Issuer FE	No	Yes	No	Yes
Observations	368	243	368	243
R-squared	0.529	0.616	0.529	0.616

NOTE. Results from specification (7). Net volumes (in millions) are measured on the investor-day-bond level for the period between February 28th and March 20th. *Dollar Share* measures the share of dollar-denominated derivative contracts of investor j at the end of Q4 2019. To facilitate the interpretation of the coefficients, we transform the variable by subtracting the cross-sectional average, before dividing it by the standard deviation. To calculate *High Share*, in Columns (3) and (4), we divide the sample of investors into below-average and above-average holders of USD derivative contracts, using the sample median as the cut-off point. Robust standard errors clustered on the issuer level are reported in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Coefficients corresponding to the constant and fixed effects not reported.

dash for cash (> 10% against sterling). However, there are two main arguments against this interpretation. First, we show in Table 8 that asset managers, which are likely subject to similar investment mandates (in terms of currency exposures) as the ICPF sector, did not discriminate between dollar bonds and non-dollar bonds in their corporate bond trading at the time. Second, and more importantly, UK insurers often choose a target hedging ratio when hedging against foreign exchange risk with derivative contracts. However, the large and sudden decline in global corporate bond markets during the Covid-19 market turmoil led to a situation in which insurers were suddenly overhedged, i.e. the decline in value of their dollar bonds led to a much higher hedging ratio than desirable. Therefore, the net sales of ICPFs during this period are unlikely to reflect an 'unforced' portfolio re-balancing, given that shifting away from dollar assets would have caused a further deviation from the target hedging ratio (see also Alstadheim et al., 2021).

Overall, in this section we have provided evidence that US corporate dollar bonds indeed faced higher selling pressure during the Covid-19 turmoil, and that this pressure both increased the liquidation cost of these operations and was higher for investors facing larger needs to meet US-dollar denominated liabilities. This suggests that, while some investors may have sold dollar assets with the (ex-ante) aim to minimize their transaction costs, others were forced to do so in order to meet dollar-denominated obligations, configuring a 'perfect storm' for liquid dollar assets.

5 Conclusion

During the outbreak of the Covid-19 pandemic, global corporate bond markets were under severe distress, with credit spreads around the globe spiking to historically elevated levels. One defining feature of this corporate bond spread widening was its heterogeneity across firms and bonds. This paper exploits a specific aspect of such heterogeneity, namely within-company variation in bond spread dynamics, to shed light on the nature of the shock hitting financial markets and its transmission mechanisms.

We show that the widening in corporate bond spreads during the Covid-19 stress period was more marked for bonds denominated in US dollars, even when controlling for observed and unobserved firm-level characteristics. Our findings are consistent with price pressures from investors selling US-dollar-denominated securities in order to secure cash dollars. We hypothesize that this dash for dollars was driven by the dollar's status as the dominant currency in international financial and trade systems, and we provide evidence supporting our interpretation using regulatory transaction-level data for the UK.

Our findings and methodology speak to a recent literature showing that US Treasury bonds carry a higher convenience yield relative to sovereign bonds of other countries—and thus highlighting the 'specialness' of US government-issued securities in global financial markets (Du et al., 2017, Jiang et al., 2021, Engel and Wu, 2022). Understanding the interaction between such specialness and the role of the US dollar as the dominant currency in the international monetary and financial system is an interesting avenue for future research.

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A Data

In this section, we first describe the details of the global corporate bond data set used in our analysis. Next, we present further details and summary statistics of the MiFID II bond transaction data and the supervisory Solvency II derivative holdings data. We then report a set of stylized facts that focus on the dynamics of corporate bond spreads at the time of the acceleration of the Covid-19 pandemic.

A.1 A Global Corporate Bond Data Set

We build a large global data set of individual corporate bonds at daily frequency for the period of January-April 2020. The bonds we consider are the constituents of a comprehensive global index of investment grade corporate bonds, the ICE Bank of America Merrill Lynch's Global Corporate Index. Our initial data set includes daily data for more than $14,500$ investment grade bonds with a residual maturity above one year, issued by about $2,900$ companies in 60 countries. The main variable of interest for our study is a bond's Option Adjusted Spread (OAS). The OAS is defined as the number of basis points that the government spot curve is shifted in order to match the present value of discounted cash flows to the corporate bond's price.[16] The data set also contains information on other bond characteristics, such as the maturity of the bond, its currency of denomination, coupon, seniority and rating.

For the empirical analysis, we exclude bonds issued by firms in the banking and financial services industries to focus on 'real economy' firms, and we also focus on senior unsecured bonds. This leads to a final data set which includes $9,063$ bonds, issued by $1,845$ firms in 56 countries. Table A.1 reports a breakdown of the number of available observations for bonds, firms, and countries of residency of the issuers.

The bonds considered are denominated in a range of currencies. US dollar-denominated bonds dominate, comprising 67% of the sample, followed by euro (24%), sterling (5%), Canadian dollar (4%), and yen (0.2%). A unique feature of our data set is the fact that many firms have multiple outstanding bonds at any given point in time. Specifically, 72% of the firms considered have two or more outstanding bonds, and 15% have bonds in two or more currencies. The average number of outstanding bonds per firm in our sample is 5, and varies from a minimum of 1 to a maximum of 98. Finally, approximately 90% of the bonds considered are issued by advanced economy firms. Specifically, about 65% of the bonds correspond to US firms, and about 25% to EU firms.

The dominance of US dollar bonds documented above is not fully explained by the prevalence of bonds issued by US firms, and it also applies to the non-US portion of our sample. While 88.5% of bonds issued by US firms are denominated in US dollars, the dollar still dominates issuance

[16] For details on the calculation of the OAS, see `https://www.theice.com/market-data/indices`.

Table A.1 Global corporate bond data set: Descriptive statistics

	Observations	Share
Observations	9,063	
of which USD	6,036	0.67
EUR	2,152	0.24
GBP	456	0.05
CAD	401	0.04
JPY	18	0.00
Firms	1845	
of which >=2 bonds	1342	0.73
>= 2 currencies	274	0.15
Countries	56	
US	4896	0.65
EA	1763	0.24
EM	840	0.11

Note. USD stands for US dollar, EUR for euro, GBP for pound sterling, CAD for Canadian dollar and JPY for yen. US stands for United States, EA stands for Euro Area and EM for Emerging Markets. Sample based on the cross-section of senior unsecured bonds issued by non-financial corporates that are available from February to April 2020.

by non-US firms, with 41% of the sample. Euro denominated bonds also make up for 41% of the non-US sample, but that is largely due to the presence of European firms. For the non-US, non-EA sample, the US dollar makes up for 58% of bonds, while the euro is the currency of denomination of 16% of the sample. This US dollar 'dominance' is nothing but a reflection of its role as the leading international currency, as documented by Maggiori et al. (2020) and Gopinath and Stein (2020), among others, and it plays a central role in the interpretation of our main empirical findings. Despite the dominance of US dollar bonds, there is still enough within-firm currency variation (i.e. firms that issue bonds in a range of currencies) to allow us to estimate currency effects using within-firm information (see Section 2).

Table A.2 reports the summary statistics in the context of corporate bond characteristics. The average bond in our sample has a face value of 790 million US dollars, a time-to-maturity of slightly below 10 years, and a coupon of 3.5%. Crucially, there is heterogeneity in the maturity dimension, with the 25th percentile being 3.5 years and the 75th percentile being 13.4 years.

In order to shed light on the role played by firm characteristics in explaining the heterogeneity in the reaction of corporate bond spreads to the Covid-19 shock, we also merge the bond database

Table A.2 SUMMARY STATISTICS OF CORPORATE BOND CHARACTERISTICS

	Mean	Median	25th pctile	75th pctile
Face value (USD m.)	789	520	400	800
Time to maturity (yrs)				
Full sample	9.9	6.5	3.5	13.4
USD	11.1	7	3.5	18.4
Non-USD	7.6	5.7	3.4	9.0
Coupon (%)	3.5	3.5	2.5	4.5

NOTE. Summary statistics for the corporate bonds in our sample. The sample consists of $9,063$ bonds issued by $1,845$ firms in 56 countries. Sample based on the cross-section of senior unsecured bonds issued by non-financial corporates that are available from February to April 2020.

described above with data on issuers' balance sheets coming from Eikon. We use the latest reported data for these companies (as of March 20th), and drop firms with the latest available information reported before December 2018. We obtain data for about $1,250$ firms out of the $1,845$ non-financial companies identified as bond issuers in our data set.

A.2 Transaction-level Data Set

We also exploit the transaction-level MiFID II database, maintained by the UK's Financial Conduct Authority (FCA). The MiFID II data provide detailed reports of all secondary-market trades meeting one of the following conditions: i) trades carried out on a UK trading venue, ii) trades in a FCA-regulated instrument on a venue in the European Union (up until 31 December 2020), and iii) trades where at least one counterparty is an FCA-regulated entity. Each transaction report contains information on the transaction date and time, ISIN, execution price, transaction size, and the legal identities of the buyer and seller. We allocate investors to an investor group (e.g. hedge funds) using a best-endeavor sectoral classification, which is naturally subject to uncertainties (e.g. allocation of insurer with asset management arm). Last, we merge our transaction-level data with information on bond characteristics (issuer, rating, etc.) from S&P Capital IQ.

Table A.3 provides descriptive statistics for our transaction data. Our sample covers the period from January 2018 to May 2020, and we obtain information on $\sim$ 2.2m trades in 7.4k corporate bonds. After filtering out non-financial bonds, we are left with $\sim$ 650k trades by $\sim 30k$ investors in 925 corporate bonds. On average, we observe a total trading volume of £1.6bn per day, with a trading volume of £293m in dollar bonds, £859m in pound sterling bonds, £472m in euro bonds, and £55m in bonds denominated in other currencies. While most of the trading volume is concentrated in sterling bonds, the majority of trades is in euro bonds (416 per day), followed by sterling bonds (343) and dollar bonds (226). We observe a total of 157 issuers and 925 bonds, with the majority of bonds issued in sterling (541), followed by dollar bonds (203) and euro bonds (170). In terms of credit quality, for dollar bonds, we observe 82 investment grade bonds, 75 high yield bonds and 46 unrated bonds. For sterling (euro) bonds, we observe 201 (93) investment grade bonds, 56 (31) high yield bonds and 284 (46) unrated bonds. The median residual maturity is 5.1 years for dollar bonds, 7.7 years for sterling bonds, and 5.7 years for euro bonds.

Table A.3 MiFID II transaction database: Descriptive Statistics

	USD	GBP	EUR	Others
Average Daily Volume (in £m)	292.92	859.47	472.07	8.40
Average Number of Trades (per day)	226.39	342.53	459.07	14.30
Number of Issuers	41	65	46	5
Number of Bonds	203	541	170	11
Investment Grade	82	201	93	7
High Yield	75	56	31	0
Not Rated	46	284	46	4
Median Residual Maturity (in Years)	5.11	7.68	5.69	5.51

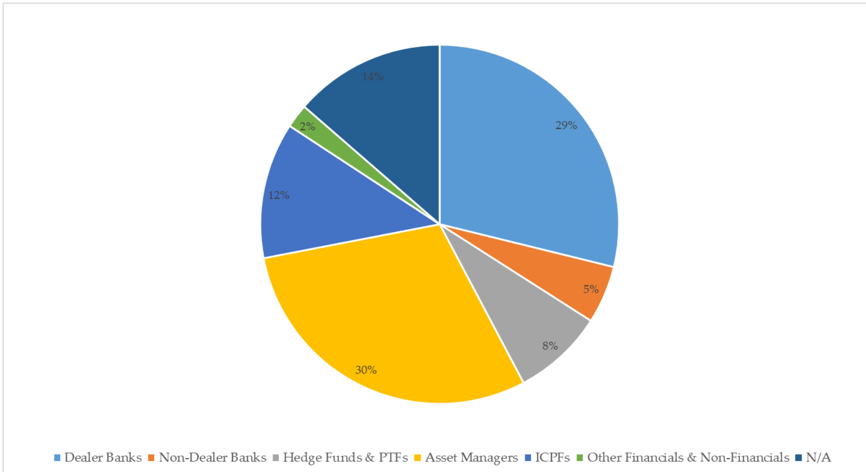
Note. Notes: This table reports summary statistics for the regulatory MiFID II bond transaction data, covering the period from January 2018 to May 2020. "Average Daily Volume" refers to the average gross trading volume of bonds in different currencies (US dollar, UK pound sterling, Euro and others) in the UK corporate bond market per day in £m. "Average Number of Transactions" measures the average number of trades in the market per day. "Number of Bonds" and "Number of Issuers" measure the number of distinctive bonds and issuers in the sample. "Investment grade" refers to bonds with a credit rating of BBB- or higher. "High yield" refers to bonds with a credit rating of BB+ or lower. "Not Rated" refers to bonds without a rating. "Residual Maturity" measures the median time in years until a bond reaches its maturity date.

Furthermore, Figure A.1 shows the average market shares of different investor types in the UK market for non-financial corporate bonds. Dealer banks and asset managers each account for around 30% of the total trading volume, while ICPFs account for 12% of the total trading volume. Other important investor types include hedge funds & PTFs (8%) and non-dealer banks (5%). As some counterparties are not registered in the UK and hence not subject to the reporting requirement, the counterparty information is not available for around 14% of the total trading volume.

Next, Figure A.2 shows the net trading volumes of different investor types in USD-denominated, non-financial corporate bonds in the UK bond market during the Covid-19 stress period (Feb 28 - Mar 20 2020). The figure shows that both dealer banks and asset managers were the main net buyers of dollar bonds during that period with combined net purchases larger than £1bn. We also find that ICPFs were the main net sellers of dollar bonds during that period with net sales of more than £600m. Other minor net sellers were hedge funds & PTFs as well as other financial & non-financial firms.

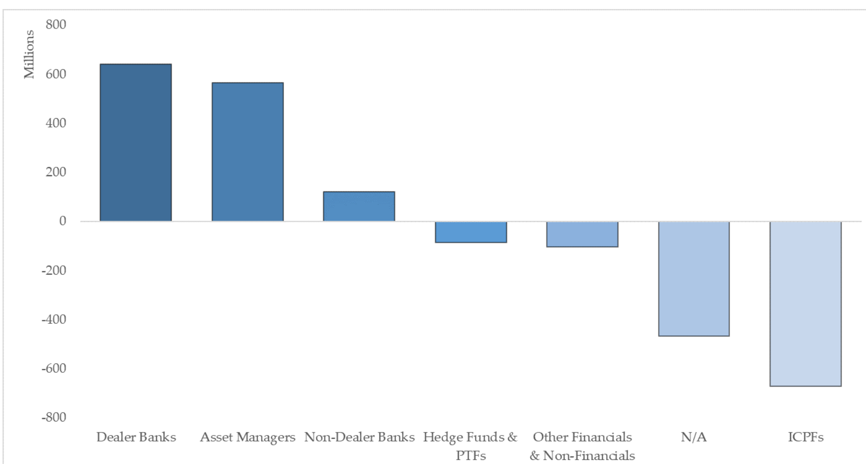
Furthermore, in Section 4, we find that dollar bonds (in particular liquid investment grade

Figure A.1 Trading Volumes - Market Share by Investor Type



Note. Average market share (by trading volume) of different investor types in the UK market for non-financial corporate bonds. Source: MiFID II bond transaction database.

Figure A.2 USD Net Trading Volumes During Covid-19 by Investor Type



Note. Net trading volumes of different investor types in USD-denominated, non-financial corporate bonds in the UK bond market during the Covid-19 stress period (Feb 28 - Mar 20 2020). Source: MiFID II bond transaction database.

bonds) experienced sharper increases in effective bid-ask spreads than non-dollar bonds. Importantly, this comes against the backdrop that dollar bonds are usually viewed as more liquid in non-stress periods, consistent with Figure 5. In Table A.4, using our within-issuer regression specification (6), we provide further evidence for the superior liquidity of dollar bonds using our entire pre-Covid sample (i.e. Jan 2018 - Feb 2020). More precisely, we find that effective bid-ask spreads of a given issuer's dollar bonds are on average around 4 basis points lower than those of the issuer's non-dollar bonds. The effect is statistically highly significant for the whole bond sample and investment grade bonds, but insignificant in our sample of high yield bonds. When we compare dollar bid-ask spreads only with those of sterling bonds, then the difference is even larger: 7.2 basis points across all bonds, and 8.7 basis points for investment grade bonds. These results therefore emphasize the superior liquidity of dollar bonds during quiet periods in the market.

Table A.4 EFFECTIVE BID-ASK SPREADS IN THE PRE-COVID PERIOD

Panel A: Dollar vs. All Currencies

	(1)	(2)	(3)	(4)	(5)	(6)
	Whole Sample		IG Only		HY Only	
Dollar Bond	-2.55**	-3.68***	-3.02	-4.18***	-0.68	-1.94
	(1.19)	(0.74)	(1.93)	(1.51)	(3.18)	(3.72)
Day FE	Yes	/	Yes	/	Yes	/
Issuer FE	Yes	/	Yes	/	Yes	/
Day × Issuer FE	No	Yes	No	Yes	No	Yes
Observations	24099	13692	14672	9173	8055	3878
R-squared	0.151	0.320	0.175	0.256	0.163	0.449

Panel B: Dollar vs. Pound Sterling

	(1)	(2)	(3)	(4)	(5)	(6)
	Whole Sample		IG Only		HY Only	
Dollar Bond	-4.71	-7.24***	-5.01	-8.70**	-5.25	-6.79
	(3.17)	(2.34)	(4.63)	(3.50)	(3.46)	(5.10)
Day FE	Yes	/	Yes	/	Yes	/
Issuer FE	Yes	/	Yes	/	Yes	/
Day × Issuer FE	No	Yes	No	Yes	No	Yes
Observations	12971	5626	6528	2750	5483	2547
R-squared	0.169	0.405	0.235	0.395	0.190	0.491

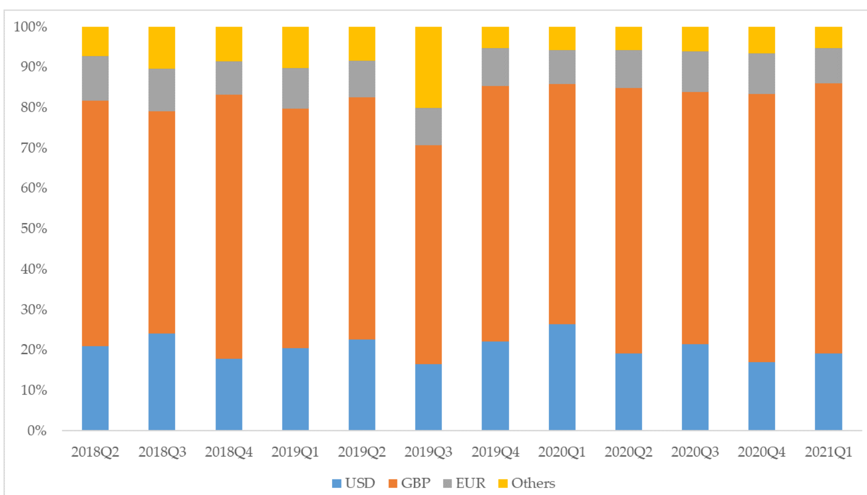
NOTE. Results from specification (6). In Panel A, we compare bid-ask spreads of dollar bonds with those of all other currencies in our sample. In Panel B, we compare bid-ask spreads of dollar bonds only against sterling bonds. The effective bid-ask spreads are measured on the bond-day level and defined as twice the difference between the trade price and the bid/ask midpoint. We focus on the pre-Covid period between January 3rd 2018 and February 27th 2020. Robust standard errors clustered on the issuer level are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Coefficients corresponding to the constant, control variables and fixed effects not reported.

A.3 Insurers' Derivative Holdings Data Set

We use granular data on derivatives holdings of insurance companies regulated by the UK's Prudential Regulation Authority (PRA) and subject to the Solvency II Directive. Insurers within scope of the Solvency II Directive are required to submit annual and quarterly returns, with the exception of some smaller firms with quarterly waivers. In total, we observe the quarterly derivative holdings of 79 UK insurers. The reports include detailed information on the derivatives holdings of a given insurer, such as the underlying security, notional amount, derivative category (e.g. FX forward), swap delivered/received currencies, and trade-level information on the identity of the counterparty. We consider both unit-linked and non-unit-linked portfolios. The data are available from 2016 Q1.

In Section 4, we hypothesize that insurers with a high share of dollar-denominated derivative contracts had to sell dollar bonds to meet VM calls (in cash dollars) during the dash for cash. Importantly, this hypothesis is based on the assumption that a significant share of UK insurers' derivative contracts is denominated in US dollars, hence accounting for a meaningful share of their total VM demands during the dash for cash. Reassuringly, Figure A.3 shows that a prominent share (around 20%) of UK insurers' derivative portfolios is denominated in dollars, which makes it the second most important contract currency after pound sterling (with a share of approx. 60%).

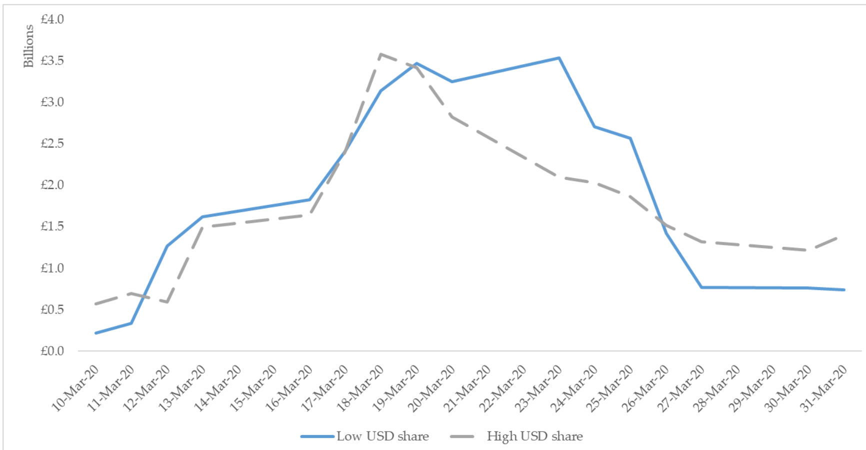
Figure A.3 Insurers' derivative holdings by contract currency



Note. Derivative holdings of UK insurers by contract currency from 2018 Q2 to 2021 Q1. Source: Solvency II holdings database.

Furthermore, a potential concern about the analysis in Table 10 is that insurers with a high share of dollar-denominated derivative contracts were exposed to higher aggregate VM margin calls compared to insurers with a low share of dollar contracts, which would mean that the former group faced more severe liquidity pressures. Importantly, as shown in Figure A.4, we find that insurers with a high share of USD contracts faced almost identical VM demands during the dash for cash compared to the group with a low share of dollar contracts. The cumulative VM demands of both groups reached a peak of around £3.5bn on March 19. Furthermore, both groups faced a rapid succession of large VM calls in the eight trading days between March 10 and 19, consistent with their pronounced net sales of gilts and corporate bonds at the time (see also Czech et al., 2021).

Figure A.4 Insurers' cumulative variation margin demands



Note. This figure shows the dynamics of the total variation margin (VM) demands in March 2020 on derivatives of UK insurers with a high share of dollar-denominated derivative contracts vs. those insurers with a low share of dollar contracts, using the sample median as the cut-off point. VM calls are estimated using the EMIR Trade Repository Data on interest rate swaps, forward rate agreements, inflation swaps, and cross-currency basis swaps. Positive (negative) values mean that the investor group was a net payer (receiver) of VM. The estimates are based on the methodology used in Bardoscia et al. (2021). The variation margin demands are in £ billion.

B Descriptive statistics & Facts

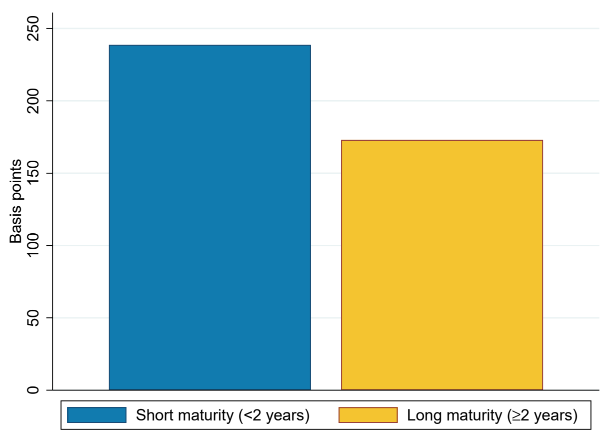
In this section, we provide some stylized facts on the behavior of corporate bonds spreads during the acceleration of the Covid-19 pandemic. Corporate bond spreads widened sharply between late February, when the rate of expansion of Covid-19 accelerated worldwide, and mid-March, when the Fed announced a series of measures to ease conditions in financial markets. The corporate bond spread of the ICE Bank of America Merrill Lynch's Global Corporate Index increased threefold, from roughly 100 basis points at the end of February to a peak of more than 300 basis points on March 23rd. While the dramatic widening of credit spreads caught the attention of most commentators, another defining feature of the stress period was that the increase in spreads was highly heterogeneous across bonds.

What bond characteristics are associated with such heterogeneity? A first look at the data shows that the increase in spreads between February 28th and March 20th was more marked for short-maturity bonds. Panel A of Figure B.1 shows that the spread of bonds with a residual maturity below two years increased, on average, by about 70 basis points more than the spread of bonds with a residual maturity of more than two years. This feature of the data is in line with the findings from recent studies, which focus on the US corporate bond market during the stress period of March 2020 (see, among others, Haddad et al., 2021).

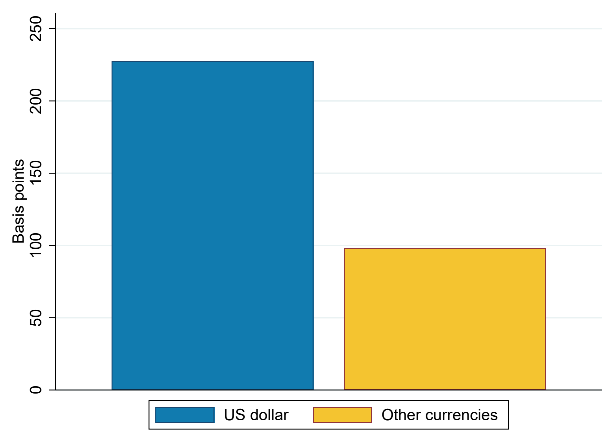
But there is a second dimension that previous studies, which exclusively focus on the US, have overlooked. Specifically, Panel B of Figure B.1 shows that the average spread increase for bonds denominated US dollars is significantly higher than the spread increase of bonds denominated in other currencies.[17] The spread on dollar bonds widened, on average, by almost 250 basis points, an increase that is more than twice as large as the increase of the spread on non-dollar bonds.

Figure B.1 Heterogeneity in spread widening:
The role of maturity and currency of denomination

(A) Heterogeneity by maturity



(B) Heterogeneity by currency

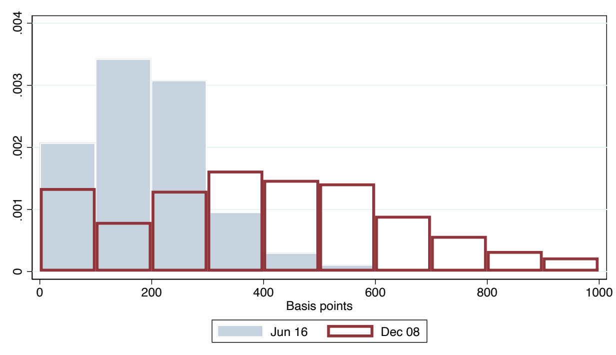


Note. Panel (A) displays the average increase of corporate bond spreads between February 28th and March 20th for bonds with a remaining maturity below and above two years. Panel (B) report the average change in corporate bond spreads over the same period but split by currency. 'Other' (non-US dollar) currencies include euro, pound sterling, Canadian dollar, and yen. Source: ICE Bank of America Merrill Lynch.

Of course, the simple unconditional sample averages in Figure B.1 are only illustrative. They could be driven by a variety of mechanisms and might be fully consistent with alternative hypotheses. To sharpen the identification of the role of bond characteristics in explaining the heterogeneity in spread dynamics, we exploit a unique feature of our data. The fact that firms have multiple outstanding bonds with heterogeneous characteristics at any given point in time allows us to exploit within-firm variation to inform our empirical estimates. The design of our exercise means that we are effectively controlling for firm-level heterogeneity in analyzing spread dynamics, hence circumventing problems associated with unobserved correlations that are difficult to control for—for example, if certain types of firms systematically issue bonds with particular characteristics.

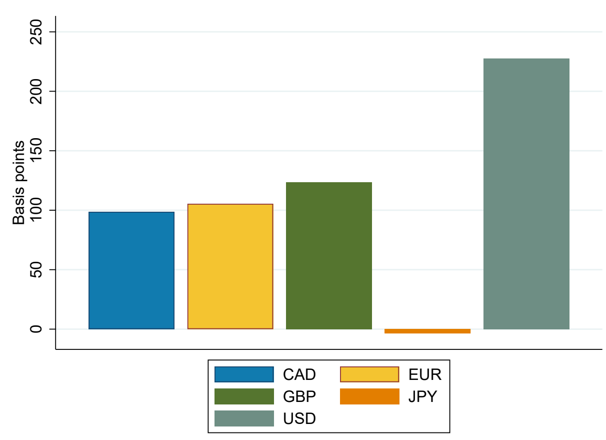
[17]The pattern is common across currencies when considered in isolation. See Figure B.3 in the Appendix.

Figure B.2 Distribution of spreads before and after GFC



Note. Empirical distribution of individual bonds option-adjusted spreads on June 16, 2008 (light blue bars) and on December 8, 2008 (transparent red bars) based on the constituents of the ICE Global Corporate Index. The chart truncates the distributions at $1,000$ basis points, as there are only marginal differences between the alternative chart using all data. Source: ICE Bank of America Merrill Lynch.

Figure B.3 Average spread increase by currency



Note. Average increase of corporate bond spreads between February 28th and March 20th for bonds denominated in different currencies. Source: ICE Bank of America Merrill Lynch.

Table B.1 Global corporate bond data set during GFC: Descriptive statistics

Observations	4068	
of which USD	2467	0.61
EUR	619	0.15
GBP	287	0.07
CAD	350	0.09
JPY	345	0.08
Firms	895	0.08
of which >=2 bonds	666	0.74
>= 2 currencies	159	0.18
Countries	44	
US bonds	2049	0.72
EA bonds	641	0.23
EM bonds	144	0.05

Note. USD stands for US dollar, EUR for euro, GBP for pound sterling, CAD for Canadian dollar and JPY for yen. US stands for United States, EA stands for Euro Area and EM for Emerging Markets. Sample based on the cross-section of senior unsecured bonds issued by non-financial corporates that are available from June to December 2008.

Table B.2 Summary statistics of corporate bond characteristics during GFC

	Mean	Median	25th pctile	75th pctile
Face value (USD m.)	3000	500	300	800
Time to maturity (yrs)				
Full sample	10.5	7.0	4.1	12.0
USD	11.7	8.0	4.6	18.3
Non-USD	8.7	5.9	3.5	10.0

Note. Summary statistics for the corporate bonds in our sample. The sample consists of 4,068 bonds issued by 895 firms in 44 countries. Sample based on the cross-section of senior unsecured bonds issued by non-financial corporates that are available from June to December 2008.

C Additional Results

C.1 The Way Down

On March 23rd the Federal Reserve announced that it would explicitly take on credit risk (with a Treasury backstop) by directly buying investment-grade corporate debt in primary (PMCCF program) and secondary markets (SMCCF) for the first time since QE was introduced in 2008.[18] This measure, the first one directly targeting the asset class analyzed in our study, can be associated with the end of the aggregate corporate spreads widening documented in Figure 1. In this section, we analyze the dynamics of spreads in the subsequent compression phase.

We follow an approach that mirrors the one employed in our main analysis. Specifically, we estimate bond-level regressions matching those in Section 2 for the period following the PMCCF/SMCCF policy announcement date. While it is tempting to interpret this analysis as an event study around the policy announcement, a word of caution is needed. In particular, the combination of the relative illiquidity in corporate bond markets (which requires using wide time windows to let prices incorporate new information) and the proximity in time of a large number of actions by the Federal Reserve warns against such interpretation.[19] Nevertheless, the regression analysis conducted here is still useful for understanding which bond characteristics were associated with a particularly sharp compression in spreads in the period following the Federal Reserve's response to Covid-related market disruptions.

Table C.1 reports the results, following the same structure as in Table 3. We run our baseline specification by focusing on the change in spreads in the first five trading days after the PMCCF/SMCCF announcement.[20] The length of the window for this exercise is similar to past studies analyzing corporate spread dynamics. For example, Gertler and Karadi (2015) consider a 10-day window in an event study similar to ours. Gilchrist et al. (2020), who present results based on 1-day, 5-day and 10-day windows, find that longer windows tend to deliver more stable and statistically significant results.[21]

Columns (1) to (4) consider the role of maturity and currency of denomination when introduced one at the time and then jointly, in line with the specification in equation (4). The results show

[18]The March 23rd Fed announcement is available at this link https://www.federalreserve.gov/newsevents/pressreleases/monetary20200323b.htm. On April 9th, the scale of this program was increased, and eligibility was widened to include high-yield bonds, provided they were rated investment-grade as of March 22nd (the so-called 'fallen angels'), see https://www.federalreserve.gov/newsevents/pressreleases/monetary20200409a.htm.

[19]The Federal Reserve announced new measures on every trading day (but one) in the period from March 15th to March 23rd. See Table 2 in Haddad et al. (2021) for a comprehensive list.

[20]Results are robust to using a 10-day window instead.

[21]The wider window used in analyses of corporate bonds (relative to Treasuries and/or equities) is motivated by the lower liquidity of the underlying assets, which might mean it takes longer for prices to incorporate news.

Table C.1 THE WAY DOWN

	(1)	(2)	(3)	(4)
US dollar (β_1)	-8.52**		-9.09**	-11.82**
	(3.46)		(3.64)	(4.27)
Maturity (β_2)		0.04	0.22**	-0.08
		(0.07)	(0.09)	(0.10)
US dollar × Maturity (β_3)				0.34**
				(0.12)
Observations	33926	33926	33926	33926
R^2	0.318	0.313	0.318	0.319
Number of Firms	286	286	286	286
Firm FE	yes	yes	yes	yes
Firm-Time FE	no	no	no	no
Double clustering	no	no	no	no

NOTE. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Coefficients corresponding to the constant, fixed effects, level of credit spread at the beginning of the sample, coupon type dummies, amortization type dummies, and bond face value not reported.

that US dollar-denominated bonds experienced a larger fall in spreads than bonds denominated in other currencies, as shown by the (strongly significant) negative coefficient on $USD_{b,i}$; and we also find that short-maturity bond spreads compressed the most in this period, as shown by the positive coefficient on $Matu_{b,i}$. Overall, there was a reversion of the dash for dollars dynamics in the days following the PMCCF/SMCCF announcement.

Can the timing and characteristics of the spread compression be informative about the mechanisms at play? In principle, Fed actions might have eased the dash for dollars through two complementary channels. First, the direct provision of US dollars to foreign central banks via swap lines might have eased access to US dollars for non-US financial institutions.[22] Second, any type of Fed action resulting in looser monetary and financial conditions might have also led to the easing of intermediaries' balance sheet constraints via a reduction in risk perceptions and an increase in prices across asset classes. With increased balance sheet capacity, financial intermediaries might have exploited the arbitrage opportunity provided by CIP deviations, putting pressure towards closing them.[23] This, in turn, could have led to a reduction in the cost of accessing US dollars synthetically, therefore reducing the need to fire-sell US dollar securities.

The unconditional properties of the data suggest that the spread dynamics uncovered in the widening period did not revert following the first Fed announcements—i.e. those covering 'standard'

[22]The Federal Reserve announced an improvement in the terms of its swap lines with the central banks on its standing network on March 15th, an expansion of the network on March 19th, and an increase in the frequency of operations for the original set of counterparties on March 20th.

[23]This mechanism has been highlighted, among others, by Du et al. (2018).

easing policies through rate cuts and traditional Quantitative Easing (i.e. the purchase of Treasuries and MBS), as well as those covering cheaper and more extensive swap lines. Indeed, credit spreads kept on increasing until March 23 (see Figure 1), with US dollar bonds displaying the largest increases. A conditional analysis based on specification (4) shows that dash for dollars dynamics intensified rather than abated in the days following those announcements. This, together with results in Table C.1, lends some weight to the hypothesis that it was the direct purchase of corporate bonds by the Fed that led to a reversion of the dash for dollars dynamics documented in the widening period.

A series of studies, complementary to ours, focus more narrowly on the effect of Fed action (PMCCF/SMCCF announcements in particular), but do not explore the role of the underlying bond characteristics beyond those warranting inclusion in the purchase programs. Specifically, Haddad et al. (2021) find that investment grade bonds with maturities of five years and less (i.e. those targeted by the Fed) experienced particularly large gains on the day of the PMCCF/SMCCF announcement. Closer to our study, Gilchrist et al. (2020) use firm fixed effects and a longer time window to find that bonds included in Fed programs experienced more pronounced increases in prices than excluded bonds of the same firm. However, neither of these studies explores the currency dimension of the bond spread dynamics resulting from the Fed's actions.

In sum, the results in this section are insightful even without narrowly identifying the effect of a particular Fed program. They show that in the week following the announcement of PMCCF/SMCCF, when the market for corporate bonds 'turned', it was spreads of US dollar-denominated bonds, particularly at the short-end, that compressed the most, even when accounting for unobserved firm heterogeneity. This is consistent with a reversion of the dynamics observed during the dash for dollars episode uncovered in Section 2.

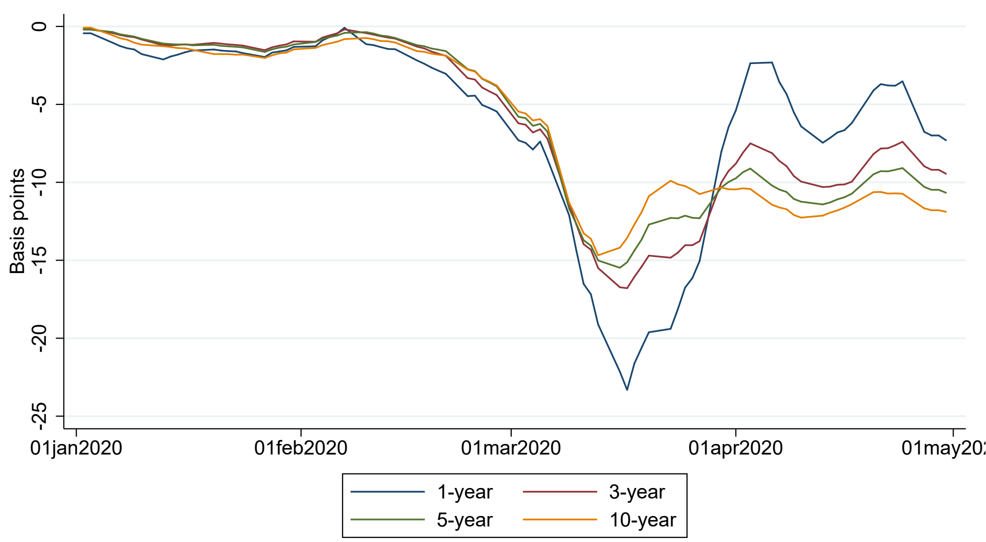
D Exchange Rate Dynamics

D.1 CIP Deviations

To provide further evidence supporting the dash for dollars hypothesis, we report some facts on CIP deviations in this section. CIP deviations measure the relative cost of obtaining US dollars 'synthetically', i.e. the difference between the dollar interest rate in the cash market and the implied dollar interest rate in the foreign exchange (FX) swap market. A negative CIP deviation means that borrowing dollars through FX swaps is more expensive than borrowing in the dollar money market.

The interpretation of our results as a 'dash for dollars' is consistent with the dynamics in FX derivative markets. Figure D.1 shows that in our sample period there was a sharp increase in the relative cost of accessing US dollars 'synthetically' (i.e. via the use of FX derivatives), which has been interpreted as a sign of US dollar shortages (see Avdjiev et al., 2020; Eren et al., 2020; Bahaj and Reis, 2020).

Figure D.1 CIP Deviations by Maturity

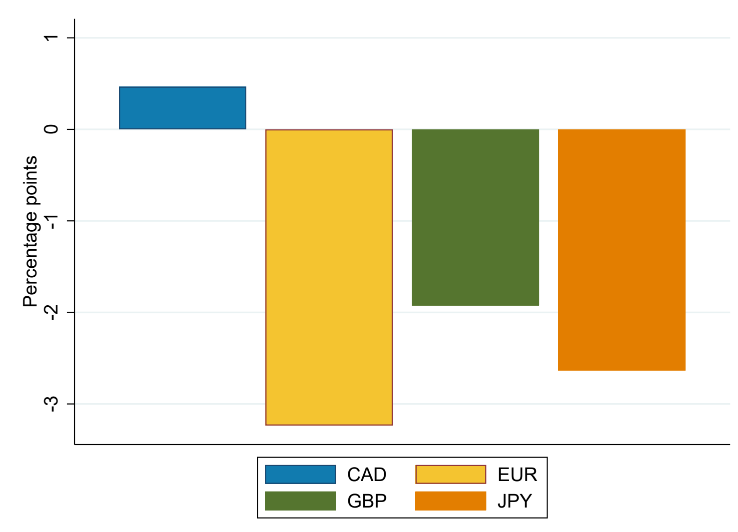


Note. Cumulative average Libor-based cross-currency bases between US dollar and euro, pound sterling, Canadian dollar and Japanese yen. Each line plots cumulative CIP deviations at a different maturity, namely 1-year, 3-year, 5-year, and 10-year. Centered 5-day moving average. Sample period: January to April 2020. Source: Bloomberg.

D.2 Exchange Rate Paths

In Figure D.2 we report the changes in the forward discount of the US dollar against other currencies in our sample period between February 28th and March 20th (the time window of our baseline regression). The forward discount is defined as the difference between the exchange rate implied by the price of an FX forward and the spot exchange rate. We report this measure for 5-year forwards in order to broadly match the median maturity of the bonds in our sample, but the picture looks very similar for alternative maturities. The bars measure the change between end-February and March 20th in the path implied by the difference between the spot exchange rate and the price of the 5-year forward exchange rate.[24] Exchange rates are defined as units of currency per US dollar. Thus, negative bars signal a worsening for the path of a currency vis-a-vis the US dollar between February 28th and March 20th. While it is not possible to get a direct read on expectations from these paths given the prominence of FX risk premia, the figure shows that the implied paths for the US dollar improved against the euro, pound sterling and yen over this period, and worsened only marginally against the Canadian dollar. Therefore, selling pressure arising from revised FX expectations are unlikely to constitute an alternative hypothesis to our baseline explanation centered on the special role of the US dollar.

Figure D.2 Changes in FX forward-implied paths against the US dollar



Note. Change between February 28th and March 20th of the difference between the spot exchange rate and the price of a 5-year forward, across a range of currencies against the US dollar. Negative values signal worsening implied paths for the currencies analyzed against the US dollar. Source: Bloomberg.

[24] We report *changes* in the path to match the focus of our regressions on changes in bond spreads.