Foreign Institutional Investors, Monetary Policy, and Reaching for Yield*

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Abstract

This paper uses security-level data of euro area investment funds' bond holdings to analyze their reaching for yield in the US dollar bond market. We find that they rebalance their US dollar bond portfolios toward higher yielding, riskier bonds when US monetary policy tightens, reflecting the effects of foreign exchange hedging. The effect is driven by the practice of hedging currency risk through rolling short-term hedging contracts. This gives rise to an erosion of the hedged yield earned on US dollar bonds when US monetary policy tightens and hedging costs increase, inducing reaching for yield in order to bolster portfolio returns. The hedging channel of monetary transmission is diametrically opposed to the classical risk-taking channel operating through US dollar-based investors, where a monetary tightening is associated with less reaching for yield. We further find that the US dollar bond purchases by euro area investment funds induced by their reaching for yield have meaningful effects on bond prices, implying that they affect conditions in the US dollar bond market.

Keywords: Monetary policy, foreign institutional investors, FX hedging, US dollar bond market

JEL Classification: E43, E52, G11, G12, G15, G23.

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1 Introduction

The US dollar (USD) bond market is the largest bond market in the world, accounting for more than 47% of the global outstanding stock of bonds (ICMA (2020)). Private foreign investors, i.e. non-USD-based-non-official investors, have played an increasingly important role in this market over the past couple of decades. In 2020, they held around 27% of the total outstanding stock of USD bonds (Du and Huber (2023)).[1]

Against this background, we examine in this paper the investment behaviour of euro area investment funds in the USD bond market which are the largest euro area holders of USD bonds.[2] Key features of these investments are (i) that they have been motivated by reaching for yield driven by low interest rates in the home economy; and (ii) that they have been largely hedged against currency risk reflecting regulatory requirements and internal risk management practices (Du and Huber (2023)). Hedging costs therefore play a key role in euro area investors' portfolio allocation decisions. Since hedging contracts are mostly short maturity and hedging costs therefore driven by short-term interest rates, this opens up a new channel of transmission of US monetary policy to the USD bond market. We explore this new channel by analyzing conceptually and empirically how euro area investment funds adjust their USD bond holdings in response to changes in the US monetary policy stance.

Our analysis fills a gap in the literature which has focused on reaching for yield in the US corporate bond market by US institutional investors, i.e. US insurance companies (Becker and Ivashina (2015) and Ozdagli and Wang (2020)) and US mutual funds (Choi and Kronlund (2017)). These studies found that US institutional investors shift toward riskier corporate bonds to generate higher returns when interest rates are low, consistent with the classical risk-taking channel of monetary policy (Borio and Zhu (2012)). Our findings suggest that foreign institutional investors in the USD bond market respond in a fundamentally different way to a change in the US monetary policy stance. Specifically, we find that when US monetary policy tightens, euro area institutional investors tilt their USD bond portfo-

[1] This number is inferred from the statistics provided in Du and Huber (2023) who estimate that foreign investors' holdings of USD bonds constitute 34% of the total value of USD bonds outstanding in 2020, out of which 77% is held by non-official sectors.

[2] Investment funds held 68% of the euro area USD bond holdings according to the ECB's Securities Holdings Statistics by Sector (SHSS) in 2020.

lios toward higher yielding, riskier bonds, reflecting the influence of hedging costs on their portfolio decisions.

The key mechanism of this hedging channel is the maturity mismatch arising from foreign exchange (FX) hedging practices of foreign investors. They invest in long-term USD bonds and typically hedge against the foreign exchange risk using short-term FX swap (or outright forward) contracts that are renewed or "rolled over" at each FX contract maturity date.[3] The hedged return of investing in USD bonds for foreign investors is thus given by the bond yield minus the currency hedging costs, which are directly affected by US short-term interest rates.[4] When US monetary policy tightens and US short-term rates rise, the hedged return of investing in Treasury and other safe USD bonds is reduced. Conceptual considerations supported by predictions of a mean-variance portfolio allocation model suggest that this has two effects. First, it reduces the attractiveness of USD bonds for euro area investors, inducing them to lower the portfolio allocation to USD bonds. Second, it may induce reaching for yield by euro area investors, i.e. a rebalancing toward riskier and therefore higher yielding USD bonds in order to increase the returns on their USD bond portfolios.

In order to test these hypotheses, we estimate a USD bond demand system for euro area investment funds. We use euro area investment funds' quarterly security-level bond holdings data to analyze how their demand for USD bonds is affected by the US monetary policy stance. The main data come from the ECB Securities Holdings Statistics by Sector (SHSS) which offers a comprehensive, fully integrated, granular dataset of the security holdings of euro area residents worldwide at the sectoral level. We also use security-level holdings data for US investors from eMAXX as part of the analysis. We merge the bond holdings data with bond yields and bond characteristics from the ESCB's Centralised Securities Database (CSDB). As such, our paper is the first – to the best of our knowledge – to construct a dataset that includes holdings of USD bonds of *both* US and foreign investors at the sectoral level.

When estimating the bond demand system, we follow Koijen and Yogo (2019) and Koijen et al.

[3] Reflecting this hedging strategy, short maturity contracts vastly dominate the FX derivatives market, see BIS (2022)).

[4] Hedging costs for euro area investors are given by the difference between the short-term rates in the U.S. and in the euro area plus a premium to acquire the US dollars in the swap market, the cross-currency basis, reflecting deviations from covered interest rate parity (CIP).

(2021). We model the weights of euro area investors' bond portfolios as a function of yield to maturity (respectively credit spreads), the USD Libor rate and bond characteristics. To address endogeneity, we use US domestic investors contemporaneous USD bond holdings as an instrument to isolate exogenous variation in yield to maturity (or credit spreads), exploiting the persistence of investment mandates (Koijen and Yogo (2019) and Bretscher et al. (2020)). We further use high-frequency (intraday) shocks to the 3-month USD Libor rate around FOMC monetary policy announcements as instruments for the underlying interest rate, following Gertler and Karadi (2015).

We find that euro area investment funds' demand for USD bonds falls when US monetary policy tightens. At the same time, we find that they tilt their USD bond portfolios toward bonds with higher yield to maturity and higher credit spreads. This stands in sharp contrast to the behaviour of domestic US institutional investors, who tilt their portfolios away from riskier USD bonds, a result established in the previous studies mentioned above.

The reaching for yield behaviour of euro area investors affects pricing in the USD bond market. We find that during quarters of monetary policy tightening in the U.S., USD bonds purchased by euro area investors display significantly higher abnormal returns. The effect quickly dissipates in subsequent quarters, suggesting that reaching for yield by euro area investors is giving rise to price pressure rather than adding information to the market.

The remainder of the paper proceeds as follows. In Section 2, we provide institutional background on euro area investment funds and explain how currency hedging affects the hedged yield of these investors in the USD bond market. Section 3 presents a stylized portfolio choice model for foreign institutional investors who invest in their domestic and in the USD bond market under currency hedging. Section 4 describes the data and provides some preliminary descriptive assessment of euro area investment funds' reaching for yield in the USD bond market. Section 5 estimates a USD bond demand system for euro area investment funds, testing the predictions of the conceptual framework. Section 6 investigates the effects of reaching for yield by euro area investors on USD bond prices. Section 7 concludes.

2 Euro area investment funds, USD bonds, and currency hedging

Over the past decade, euro area investors have funneled large amounts of funds into the USD bond market. Their notional holdings of USD bonds rose from $1.6 trillion at the start of 2014 to more than $2.6 trillion at the end of 2019. This translates into more than 5% of the total outstanding stock of all USD bonds.[5] These large flows were mainly driven by investment funds (Carvalho and Schmitz (2023)) who intermediated 69% of such flows.[6]

Figure 1 shows the currency composition of the euro area investment funds' bond portfolio. The size of the total bond portfolio has increased from $4.1 trillion at the start of 2014 to more than $5.5 trillion at the end of 2019, in notional value. In terms of portfolio allocation, the weight of USD bonds increased from 23.1% to 31.8% over the same period. This came at the expense of the share of euro denominated bonds which went down from 63.2% to 51%.

The growing investments of euro area investment funds in the USD bond market were primarily driven by low domestic bond yields and the effects of currency hedging on hedged returns.

Low domestic bond yields: Euro area institutional investors faced persistently low domestic bond yields in the wake of accommodative euro area monetary policy to counter first the euro area debt crisis and then persistent low inflation. This created incentives to reach for yield in other, higher-yielding bond markets to generate higher returns.

This reaching for yield occurred to a large extent in the higher-yielding USD bond market also owed to its size advantage. The size of the euro area non-sovereign bond market segment has not kept up with the growth of assets under management of euro area institutional investors. The deleveraging of euro area banks in the wake of the GFC which also led to a significant reduction in banks' outstanding debt securities was not compensated by an equivalent increase in outstanding debt securities of other financial and non-financial firms (Koijen et al. (2021)). By the end of 2019, the outstanding

[5] The outstanding stock of all USD bonds is estimated as the sum of the outstanding stock of US bonds reported by the US Securities and Financial Markets Association (SIFMA) and the USD debt securities outstanding outside the U.S. from the International Debt Securities Statistics published by the Bank for International Settlements (BIS).

[6] The remaining share of euro area flows into USD bonds was mainly driven by banks who will not be the subject of this paper as a significant portion of their USD bonds holdings is hedged with USD liabilities, including deposits and capital market borrowing (Du and Huber (2023)).

stock of the euro-denominated bond market was €19.4 trillion,[7] only €1.7 trillion higher than at the start of 2014. Moreover, the share of the outstanding euro-denominated bonds that was held by the Eurosystem increased from 0% at the start of 2014 to 15% at the end of 2019, reducing the net supply of bonds to the public. By contrast, the USD bond market is by far the largest bond market globally, making it an attractive destination for foreign investors in search for higher-yielding investment opportunities. It grew substantially over the the last decade. The outstanding stock of USD bonds amounted to $44.1 trillion at the end of 2019, up by $8.2 trillion compared to the start of 2014. At the same time, the share of the outstanding USD-denominated bonds that were held by the Federal Reserve went down from 9.75% at the start of 2014 to 8% at the end of 2019, thus increasing the net supply of USD bonds to the public.

Currency hedging and hedged yields: There are two reasons for hedging FX risk of foreign investments. The first is domestic regulatory requirements that are faced by end investors such as insurance companies and pension funds. For example, the EU's Solvency II directive, which came into effect in January 2016, stipulates that European insurers face a 25% solvency capital charge applicable in the event of currency mismatches between insurance companies' assets and liabilities. The second is internal risk management practices. Meese and Rogoff (1983) and Perold and Schulman (1988) suggest that short-term currency movements follow a random walk, representing a source of uncompensated risk. This implies that an unhedged investment in foreign bonds provides little value to investors given high exchange rate volatility while, because of liquid US dollar hedging markets, investing on an FX hedged basis is a strategy that is easy to implement.

Based on the Morningstar share-class-level indicator, Du and Huber (2023) conservatively estimate that mutual funds domiciled in 64 non-US countries hedge on average 44% of their USD bond investments. However, this figure should be considered as a lower bound hedging ratio for USD bonds as it does not cover internal hedges by end-buyers such as insurance companies who face regulatory requirements to hedge FX exposures such as the Solvency II directive in the EU mentioned above. These strict regulatory requirements may also induce euro area investment funds to have

7 The outstanding stock of all euro bonds is estimated as the sum of the outstanding stock of euro area bonds reported by the ECB debt securities database and the euro debt securities outstanding outside the euro area from the International Debt Securities Statistics published by the Bank for International Settlements (BIS).

higher hedging ratios, internalising the hedging requirements of their end-buyers. Consistent with this notion, Czech et al. (2021) show that UK insurers, who were facing Solvency II until the UK exited the European Union at the end of 2020, hedge 50% of their USD securities which are allocated evenly between bonds and equity. Given that the FX hedge ratio is higher for bonds than for equities, this indicates that UK insurers hedge most of their USD bonds which is consistent with the theoretical prediction in Campbell et al. (2010) and empirical data presented in Du and Huber (2023). There is also anecdotal evidence (Borio et al. (2016), Pando (2019) and Dauphine et al. (2021)) that European institutional investors usually hedge most of their exposure to foreign currency bonds. Importantly, this hedge ratio for foreign institutional investors is stable or increasing even when hedging costs rise (Du and Huber (2023) and Bank of Japan (2022)[8]).

Hedging of FX risk is generally implemented through short-term FX swap (or outright forward) contracts that are renewed or "rolled over" at each FX contract maturity date until reaching the maturity of the respective USD bonds. Foreign investors do so for two reasons. First, to take advantage of the yield differential between the higher yielding USD and their low yielding currency. This is mainly determined by the shape of the USD yield curve. Second, short term swaps are the most liquid market for FX hedging, and so trading costs tend to be lower using these instruments compared to more tailored longer-term swaps.[9] As a result, foreign institutional investors follow a "hedge short and invest long" strategy. In other words, they invest in long-term bonds, but hedge the currency through short-term swaps on a rolling basis, thus incurring a maturity mismatch.

In a textbook setting, the FX cross-currency basis swap would be given by the short-term USD-EUR interest rate differential, giving rise to the academically revered no-arbitrage condition of covered interest rate parity (CIP). However, in the wake of the GFC, persistent deviations from CIP have emerged (Borio et al. (2016), Du et al. (2018) and Avdjiev et al. (2019)). For jurisdictions with large cumulative current account surpluses and increasing gross foreign asset positions such as the euro

[8] Bank of Japan (2022) states that even with a rise in U.S. dollar hedging costs and "the depreciation of the yen, life insurance companies' attempt to increase their exposure to foreign exchange risk has been limited. Currency hedge ratios of their foreign securities investment have remained flat."

[9] According to the 2019 BIS Triennial Central Bank Survey of Foreign Exchange and Derivatives Market Activity (BIS (2019)), USD FX swaps (forward contracts) with maturity of six months or less account for 98% (95%) of their respective turnover. The 2022 Triennial Survey (BIS (2022)) confirms that short maturity contracts dominate the FX derivatives market.

area and Japan, the cross-currency basis has commonly been negative. This increased FX hedging costs for domestic investors who invest in USD assets.

The 3-month EUR/USD swap rate is formalized as follows:

$$\text{EUR/USD Swap Rate}_{3\text{month}} = \text{USD Libor}_{3\text{month}} - \text{Euribor}_{3\text{month}} - \text{CCB}_{3\text{month}}. \tag{1}$$

Equation 1 shows that the swap rate depends on the difference between policy rates in the U.S. and the euro area and on the cross-currency basis (CCB). As a consequence, when US monetary policy is tightened, the cost for a euro area investor to hedge a USD-denominated long-term bond increases. Figure 2 shows that the 3-month USD Libor was the main driver of the swap rate between 2013 and 2021. The 3-month Euribor and the cross-currency basis were consistently negative, thus adding to hedging costs for euro area investors.

With hedging costs given by the 3-month EUR/USD swap rate defined in equation 1, the hedged yield of a US Treasury bond for a euro area investor under full hedging of the FX exposure is given by:

$$\text{Hedged USD Treasury Bond Yield} = \text{USD Term Spread} + \text{Euribor}_{3\text{month}} + \text{CCB}_{3\text{month}} \tag{2}$$

Equation 2 shows that the hedged yield of a US Treasury bond for a euro-based investor is given by the sum of the US term spread (the difference between long-term and short-term US interest rates), the Euribor rate, and the cross-currency basis. Given that both Euribor and cross-currency basis were consistently negative since the start of the ECB's quantitative easing program in 2015, the US term spread was the key factor driving the hedged return for euro area investors. The empirical literature (e.g. Gertler and Karadi (2015) and Nakamura and Steinsson (2018)) suggests that long-term interest rates respond less to a monetary policy shock than short-term rates. Indeed, the coefficient of correlation between the 3-month USD Libor rate and term spread (based on the yield on the 10-year US Treasury bond minus the 3-month USD Libor rate) is -0.80 from 2008 till 2019 based on quarterly data with a t-statistic of -7.80. This means that a US monetary policy tightening increasing short-term interest rates is associated with an erosion of the hedged yield differential for euro area investors as the US yield curve flattens.

Reflecting this regularity, the hedged yield on US Treasury bonds for euro area investors was consistently negative over the sample period as the Federal Reserve tightened monetary policy. This is shown in Figure (3a) which plots the 10-year synthetic euro area sovereign bond yield and the 10-year US Treasury bond yield both on an unhedged and and on a hedged (based on a rolling 3-month FX swap) basis. Thus, for euro area investors, even with yields at multi-year highs, US Treasuries were yielding less than euro area bonds when accounting for hedging costs.

Non-Treasury USD bonds, such as US corporate bonds, typically earn a spread reflecting higher credit risk on top of the Treasury yield. The hedged yield of a euro area investor in a non-Treasury USD bond is therefore given by:

$$\begin{aligned} \text{Hedged non-Treasury USD Bond Yield} &= \text{USD Term Spread} \\ &+ \text{Credit Spread} + \text{Euribor}_{3\text{month}} + \text{CCB}_{3\text{month}} \end{aligned} \tag{3}$$

As an example, Figure 3b shows the unhedged and hedged (using a rolling 3-month FX swap) US corporate bond yield for AAA- and BBB-rated corporate bonds. The chart reveals that the situation was not much different for AAA-rated US corporate bonds than for US Treasury bonds. The hedged yields on AAA-rated corporate bonds for euro area investors was below the euro ares sovereign yield most of the time between 2013 and 2020. The only segment in the US investment grade corporate bond market with a hedged yield above the euro area sovereign yield during this period were the BBB-rated corporate bonds. Thus, in order to earn a positive yield in the USD bond market, euro area investors had to reach for yield by taking extra credit risk.

Overall, these considerations suggest that monetary policy tightening in the U.S. (i) reduces the attractiveness of USD bonds for euro area investors, possibly inducing them to reduce their portfolio allocation to this asset class; and (ii) increases the attractiveness of higher yielding USD bonds with higher credit risk for euro area investors, possibly inducing them to reach for yield and rebalance their USD bond portfolio toward such riskier bonds.

3 A simple portfolio choice model for foreign investors

This section sketches a one-period portfolio optimization model for a euro area institutional investor which can be generalized to any foreign institutional investor investing in the USD bond market. The model is meant to provide a conceptual illustration of the hedging channel described in the previous section and therefore involves many simplifying assumptions. We will only consider two points in time t = 0 (today) and t = 1 (three months from now). At time 0, the investor chooses a global bond portfolio to achieve the return objective. To describe the portfolio re-balancing implications of FX hedging, we solely consider bonds issued in US dollar and euro. Moreover, to zoom in on the implications of euro area institutional investor's FX risk management for their reaching for yield, we solely focus on credit risk and currency risk and abstract from interest rate risk.

At time 0, the investor's investment opportunity set consists of the following two bond portfolios:

1. USD bond portfolio with expected return $r_\$ = y_\$ + T_\$ + C_\$$, credit risk $C_\$^\alpha$ where $\alpha > 0$, and allocated weight w.

2. Euro bond portfolio with expected return $r_e = y_e + T_e + C_e$, credit risk C_e^α where $\alpha > 0$, and allocated weight $1 - w$.

y_e is the euro area 3-month interest rate and $y_\$$ is the US 3-month interest rate. They stand as proxies for the short-term rates. The euro area and US term spreads are given by T_e and $T_\$$, respectively. C_e is the credit spread of the euro area corporate bond portfolio over the euro area sovereign bond with the same maturity. Similarly, $C_\$$ is the credit spread of the USD bond portfolio over the US Treasury bond with the same maturity. Given the sensitivity of the term spread to monetary policy documented above, we model the term spread as $T_\$ = T_\$^* - \rho\, y_\$$, where $\rho > 0$ captures the negative association between the term spread and short-term rates. The parameter ρ was estimated in Section 2 to be 0.80. Finally, for simplicity, short-term rates and credit spreads are assumed to be independent of one another.[10]

[10] This simplifying assumption loads the dice against our hypothesis. Relaxing it by assuming that the the credit spread would increase when monetary policy tightens, which would be consistent with the classical risk-taking channel, would further strengthen the case for euro area investors re-balancing to USD bonds with higher spreads when US policy rates rise.

FX hedging: The euro area investor hedges the currency risk of a share ϕ of her USD bond portfolio, where $\phi \in [0,1]$. The hedge ratio is assumed to be constant as highlighted in Section 2. The investor uses a 3-month cross-currency swap to implement this hedging. The cost of hedging is $H(y_\$, y_e) = y_\$ - y_e - Z$. $Z < 0$ captures the persistent negative cross-currency basis reflecting the premium that euro area investors need to pay in order to access the US dollar in the swap market that was discussed before. Finally, the investor will face exchange rate fluctuations for the share 1 - ϕ of the US bonds that are not hedged. The expected return of the currency movement is F with associated risk of σ_f^2. The FX fluctuations are assumed to be independent of the bond returns for simplicity.

The euro area investor has mean-variance preferences over the return on bonds, but faces the cost of FX hedging. Thus, the investor chooses his bond portfolio such that:

$$\underset{w}{\text{maximize}} \quad w\, r_\$^* + (1-w)\, r_e - (\frac{\xi}{2})[\, w^2 \sigma_\$^* + (1-w)^2 C_e^\alpha \,] \tag{4}$$

where ξ captures the investor's aversion to volatility in the return on bonds. $r_\$^*$ is the expected return on the USD bond portfolio net of the cost of the FX hedging and the expected FX fluctuations: $r_\$^* = r_\$ + (1-\phi)F - \phi H(y_\$, y_e)$. $\sigma_\$^*$ is the volatility in the return on the USD bond portfolio after taking into account the currency fluctuations: $\sigma_\$^* = C_\$^\alpha + (1-\phi)^2 \sigma_f^2$. We assume short selling is allowed for simplicity. Equation 4 highlights two separate sources of volatility. The first is the credit risk embedded in the USD and euro bond portfolios. The second is the FX risk arising from the $1-\phi$ unhedged portion of the USD portfolio.The first-order condition yields the following solution for the optimal weight of the USD bond portfolio, w^* :

$$w^* = (\frac{1}{\xi}) \cdot \frac{(r_\$^* - r_e) + \xi\, C_e^\alpha}{C_\$^\alpha + C_e^\alpha + (1-\phi)^2 \sigma_f^2} \tag{5}$$

Equation 5 implies that the optimal demand for the USD bond portfolio is determined by two factors. The first is the hedged yield premium of the USD bond portfolio over the euro bond portfolio. The second is the credit risk of the euro bond portfolio. The implications for the impact of a change in the US monetary policy stance on USD bond portfolio demand by the euro area investor are the following:

Implication 1: When the FX hedging ratio is high, $\phi > 1-\rho$, US monetary policy tightening discourages euro area investors from investing in USD bonds ($\frac{\partial w^*_{C\$}}{\partial y_\$} < 0$). We prove this in the Appendix. All else equal, the higher the US short-term rate, the more compressed the term spread will get, eroding the yield differential for euro area investors. This is the direct result of the term spread compression parameter (ρ).

Implication 2: For investors fulfilling the condition for implication 1, a tighter US monetary policy will lead to stronger demand for USD bonds with higher yields and higher credit risk. In other words, the higher the cost of hedging, the more risk taking in the USD bond market by the euro area investor ($\frac{\partial^2 w^*_\$}{\partial C_\$ \partial y_\$} > 0$). We prove this in the Appendix. All else equal, tighter US monetary policy compresses the US term spread and erodes the yield differential for euro area investors, which induces them to bolster their returns by investing in higher yielding bonds and taking on more credit risk.

These implications yield the following testable predictions:

Prediction 1: Euro area investors' demand for USD bonds is decreasing when US monetary policy tightens and short-term rates rise as this implies an increase in the cost of hedging of USD exposures.

Prediction 2: Euro area investors' re-balance their USD bond holdings toward riskier bonds with higher yields and credit spreads when US monetary policy tightens and US short-term interest rates rise. The negative impact of higher US short-term interest rates on euro area investor's USD bond holdings will therefore decrease in the level of the bond's credit spread, implying a positive interaction effect between the two variables.

4 Data and stylized facts

4.1 Data

For the main part of the analysis, we use security-level data on bonds held by euro area investment funds over the sample period 2016Q1 until 2019Q4. The sample period is determined by data availability and covers the last full US monetary policy tightening cycle. We use notional values of bond holdings reflecting active choices by investors through new investments and portfolio shifts, rather than changes in market prices. The data source is the ESCB Securities Holdings Statistics by Sector (SHSS).

The data in the SHSS are collected by the national central banks of the Eurosystem from financial investors and custodians on a quarterly basis since 2016Q1. The dataset covers debt securities, listed shares as well as investment fund shares, all of which are in most cases identified with a unique International Securities Identification Number (ISIN). A financial institution resident in the euro area is obliged to report securities that it holds as its own investment ("direct reporting") as well as securities that it holds in custody ("indirect reporting"). Investors in the SHSS are defined by their country of domicile and sector.

Using the ISIN for the held securities, we merge the SHSS data with individual asset characteristics obtained from the ESCB's Centralised Securities Database (CSDB) which contains information on more than six million debt and equity securities issued globally (Rousová and Caloca (2018) and Bergant et al. (2020)). That way we obtain security-level yields, prices, credit ratings and other bond characteristics. We use the yield curve constructed by Gürkaynak et al. (2007) to calculate bonds' credit spread by subtracting the yield of the corresponding Treasury security with the same maturity from the yield of the respective USD bond.

We also use in the analysis security-level bond holding data of US investors. Specifically, we use security-level bond holdings of the Federal Reserve in the System Open Market Account (SOMA) portfolio from the Federal Reserve Bank of New York and security-level bond holdings of US mutual funds and insurance companies from the eMaxx Thomson Reuters database.[11]

Table 1 reports the summary statistics for the USD bond portfolio information of euro area investment funds, US mutual funds and US life insurance companies. The statistics suggest that euro area investment funds tend to hold bonds with similar yields and credit risk as US mutual funds but higher yields and risk compared to US life insurers. The median credit spread of USD bonds held by

[11] eMaxx provides comprehensive coverage of both sectors' bond holdings. As of the end of 2019, eMAXX covers \$5.11, \$3.62 and \$1.01 trillion in par value of bond holdings by mutual funds, life insurance companies, and Property and casualty insurance companies respectively. This is very close to the bond holdings reported in the US flow of funds for the two sectors. eMAXX also includes bond holdings by pension funds and investment management companies but with less comprehensive coverage.

euro area investment funds is around 1.91 %, with a standard deviation of 2.72%. Interestingly, euro area investors tend to hold bonds with larger amounts outstanding than the US mutual funds and life insurers, suggesting a preference for larger bond issuances. This can reflect a preference for more liquid bonds possibly to facilitate the portfolio re-balancing due to the change in the hedging costs.

4.2 Currency hedging and the demand for USD bonds

As a preliminary assessment of the effect of US monetary policy on foreign institutional investors' demand for USD bonds, we look at the correlation between hedging costs and demand for USD bonds by euro area investment funds. To this end, Figure 4 plots the hedged yield on the 10-year US Treasury bond calculated using a rolling 3-month FX swap together with USD bond purchases by euro area investment funds (12-month rolling window) over the period 2016-2019 which was a period of US monetary policy tightening.

The chart shows a clear positive correlation between the hedged yield and euro area investment funds' USD bond purchases. There were large purchases between 2016 and mid-2018 when the hedged Treasury yield was still positive. When the hedged Treasury yield then turned negative toward the end of the hiking cycle, euro area investment funds' purchases dropped sharply. They fell to only $ 9 billion of USD bonds from 2018-Q2 till 2019-Q2 compared to $ 218 billion of USD bonds a year earlier, driven in particular by outflows of $18.3 from US Treasury bonds and $58 billion from investment grade USD bonds.

These observations suggest that tighter US monetary policy compressing the US term spread and eroding the yield differential on a hedged basis, reduces the attractiveness of USD bonds for euro area investment funds. This is consistent with the previous conceptual considerations, specifically prediction 1 of the model. At the same time, US monetary policy tightening appears to induce a portfolio rebalancing of euro area investment funds away from investment grade and toward higher yielding bonds to improve portfolio returns, an effect which will be examined more closely in the next subsection.

4.3 Measuring reaching for yield in the USD bond market

We next conduct a more direct preliminary assessment of how the incentives of euro area investors to invest in higher yielding USD bonds *relative* to other investors in the market are related to the level of the US policy rate. To this end, we compare the weighted average yield to maturity of euro area investment funds' USD bond holdings to the weighted average yield to maturity of US mutual funds' USD bond holdings.

Specifically, we define the relative reaching for yield ($RRFY$) of euro area investment funds at date t as the weighted average yield to maturity of their USD bond portfolio relative to the weighted average yield to maturity of USD bonds held by US mutual funds:

$$RRFY_t = \frac{\sum_i H_{i,t} YTM_{i,t}}{\sum_i H_{i,t}} - \frac{\sum_j V_{j,t} YTM_{j,t}}{\sum_j V_{j,t}} \tag{6}$$

where $YTM_{i,t}$ is the yield to maturity of bond i, $H_{i,t}$ is the amount of bond i held by the euro area investment funds, and $V_{j,t}$ is the amount of bond j held by the US mutual funds. In other words, the first part of equation 6 represents the weighted average yield to maturity of the euro area investment funds' USD bond portfolio and the second part represents the weighted average yield to maturity of the US mutual funds' USD bond portfolio.[12]

Figure 5a plots our $RRFY$ measure for euro area investment funds versus the 3-month US dollar Libor. The chart shows that a one percentage point increase in the USD Libor rate is associated with a 0.41-point increase in the excess yield to maturity of euro area investors' USD bond portfolios relative to US mutual funds. The t-statistic of the slope coefficient is 8.33. Therefore, when monetary policy tightens in the U.S., euro area investment funds tilt their portfolios toward higher-yielding USD bonds, in line with our previous conceptual considerations, specifically prediction 2 of the model.

Reaching for yield can take the form of increasing holdings of bonds with greater credit risk (Becker and Ivashina (2015)) or of lengthening the bond portfolio's duration and adding more duration risk

[12] Comparing the relative yield to maturity of euro area investment funds USD portfolio to the one held by US mutual funds allows us to control for unobservable factors that drive variation in the market yields. The main advantage of our approach is that it cancels out any bias, as our $RRFY$ measure is defined as deviations of average bonds' yield to maturity from the average yield to maturity of other bonds.

(Ozdagli and Wang (2020)). To disentangle the two forms, we repeat the same exercise and calculate the $RRFY$ measure using the weighted average credit spread rather than the weighted average yield to maturity:

$$RRFY_t = \frac{\sum_i H_{i,t} CS_{i,t}}{\sum_i H_{i,t}} - \frac{\sum_j V_{j,t} CS_{j,t}}{\sum_j V_{j,t}} \tag{7}$$

The credit spread $CS_{i,t}$ of bond i is defined as the spread of the yield-to-maturity of USD bond i over the Treasury yield of similar maturity according to the yield curve constructed by Gürkaynak et al. (2007). Using the weighted average credit spreads instead of the weighted average yield to maturity also produces positive estimates of equation 6. A one percentage point increase in the USD Libor rate is associated with a 0.31 percentage point increase in the excess credit spread of euro area investors' USD bond portfolios relative to the US mutual funds' USD bond portfolio (5b). The t-statistics of the slope coefficient is 6.44. Thus, when monetary policy tightens in the U.S., euro area investors tilt their portfolios toward relatively higher-yielding USD bonds with higher credit risk.

Next, we repeat the same exercise using the US life insurers' USD bond holdings as the benchmark. Figures 5c and 5d show that a one percentage point increase in the USD Libor rate is associated with a 0.33 and 0.13 percentage point increase in the excess yield to maturity and credit spread of euro area investment funds' USD bond portfolios relative to the US life insurers, respectively. The t-statistic of the slope coefficients are 4.64 and 1.94 for the yield to maturity and the credit spreads, respectively.

Finally, we investigate whether the incentives of euro area investment funds to invest in higher yielding USD bonds *relative* to the market is related to the level of the US policy rate. To this end, we compare the weighted average yield to maturity and credit spread of euro investors' USD bond holdings to the weighted average yield to maturity and credit spread of the aggregate USD bond portfolio in the market (Choi and Kronlund (2017)) and Ozdagli and Wang (2020)). Specifically, we define the relative reaching for yield ($RRFY$) of euro area investors at date t as the weighted average yield to maturity or credit spread of the euro area investment funds' bond portfolio relative to the weighted average yield to maturity or credit spread of all outstanding USD bonds in the market. We use the CSDB to calculate the weighted average yield to maturity of the aggregate USD bond portfolio outstanding in the market.

Figures 5e and 5f show that a one percentage point increase in the USD Libor rate is associated with a 0.26 and 0.74 point increase in the excess yield to maturity and credit spread of euro area investment funds' USD bond portfolios relative to the market, respectively. The t-statistics of the slope coefficients are 2.04 and 4.99 using yield to maturity and credit spreads, respectively. This confirms the earlier estimates that when monetary policy tightens in the U.S., euro area investment funds tilt their portfolios toward higher-yielding USD bonds with higher credit risk relative to the market, consistent with prediction 2 of our model.

5 Empirical analysis

5.1 A US dollar bond demand system for euro area investment funds

In order to assess the hedging channel more formally, we estimate a USD bond demand system for euro area investment funds to test how these investors adjust their bond allocation in the wake of changes in the US monetary policy stance. The demand system is estimated at the security level and takes the following form:

$$\mathrm{w}_{it} = \beta_{1,i}\,\mathrm{YTM}_{it} + \beta_{2,i}\; y_t^{\$} + \beta_{3,i}\,\mathrm{YTM}_{it} \cdot\; y_t^{\$} + \alpha_i + \epsilon_{i,t} \tag{8}$$

where w_{it} is the euro area investment funds' global bond portfolio allocation to USD bond i at time t. YTM_{it} is the yield to maturity of bond i's yield to maturity at time t and $y_t^{\$}$ is the USD Libor rate.

In another specification of the model, we estimate the model controlling for time-specific bond demand factors by including time fixed effects, α_t, and therefore excluding the USD Libor rate, respectively.

$$\mathrm{w}_{it} = \beta_{1,i}\,\mathrm{YTM}_{it} + \beta_{3,i}\,\mathrm{YTM}_{it} \cdot\; y_t^{\$} + \alpha_i + \alpha_t + \epsilon_{i,t} \tag{9}$$

To control for time-invariant bond characteristics, all regressions include bond fixed effects which are denoted by α_i. The component of demand that is not captured by prices, bond characteristics, and time-invariant characteristics, $\epsilon_{i,t}$, is referred to as latent demand. Finally, we cluster standard errors by issuer because some issuers have several traded bonds over our sample.

In an alternative specification of the model, we use the credit risk spread CS_{it} of bond i's instead of the yield to maturity.

$$\mathrm{w}_{it} = \beta_{1,i}\,\mathrm{CS}_{it} + \beta_{2,i}\,y_t^{\$} + \beta_{3,i}\,\mathrm{CS}_{it}\cdot\,y_t^{\$} + \alpha_i + \epsilon_{i,t} \tag{10}$$

$$\mathrm{w}_{it} = \beta_{1,i}\,\mathrm{CS}_{it} + \beta_{3,i}\,\mathrm{CS}_{it}\cdot\,y_t^{\$} + \alpha_i + \alpha_t + \epsilon_{i,t} \tag{11}$$

The credit risk spread is defined as the yield spread of bond i's over the Treasury yield of similar maturity according the yield curve constructed by Gürkaynak et al. (2007). $y_t^{\$}$ is the 3-month US dollar Libor rate.

The key coefficients of interest are β_2 and β_3. The coefficient β_2 captures the direct effect of a change in the USD Libor rate on USD bond holdings. Our conceptual model implies a negative β_2, meaning that bond holdings would decline when US monetary policy is tightened and short-term US rates increase. The coefficient β_3 captures the search-for-yield effects through the hedging channel. These effects operate through the interaction between the yield to maturity (respectively the credit spread) of the bond and the US monetary policy stance. The model predicts a positive coefficient ($\beta_3 > 0$), meaning that tighter US monetary policy induces portfolio rebalancing toward higher yielding and riskier USD bonds.

5.2 Instrumental variable approach

We estimate equation 8 using instrumental variable techniques since prices, i.e. the yield to maturity, the credit spread and the USD Libor rate, can be endogenous to latent demand.[13] For the yield to ma-

[13] Endogeneity may arise for three main reasons. First, euro area investment funds cannot be assumed to be atomistic with demand shocks of non-negligible price impact. Second, correlated demand shocks with other investors could have price impact in the aggregate, which rules out any factor structure in latent demand. Third, there is a possibility that economic activity fluctuates in response to exogenous non-financial factors, and the USD Libor simply reflects these changes in real activity.

turity and the credit spread of a bond, we construct instruments based on the Koijen and Yogo (2019) framework applied to USD bonds as in Bretscher et al. (2020), using other investors' portfolio holdings as an instrument to isolate exogenous variation in yields to maturity (respectively credit spreads). To construct this instrument for euro area institutional investors' bond holdings in the USD bond market, we use contemporaneous bond holdings of domestic US investors from the eMaxx database as well as the Federal Reserve's holdings in the System Open Market Account (SOMA) portfolio.

In estimating euro area investment funds' bond demand, the instrument for the yield to maturity and the credit spread of a bond i is:

$$Y\hat{T}M_{i,t} = log\left(\sum_{j \neq EA} A_{j,t} \frac{\mathbb{1}_{j,t}}{1+\sum_i \mathbb{1}_{j,t}}\right) \tag{12}$$

$$\hat{CS}_{i,t} = log\left(\sum_{j \neq EA} A_{j,t} \frac{\mathbb{1}_{j,t}}{1+\sum_i \mathbb{1}_{j,t}}\right) \tag{13}$$

where $A_{j,t}$ is the total holdings of USD bonds by US investor j at time t and $\mathbb{1}_{j,t}$ equals one if investor j at time t has positive holdings of bond i. This instrument depends only on the contemporaneous holdings of US investors at the fund level as a definition for their investment universe. The instrument can be interpreted as the counterfactual yield to maturity (credit spread) if other investors were to hold an equal-weighted portfolio within their investment universe. For example, if US mutual funds held an equal-weighted portfolio of USD bonds, US life insurance funds held an equal-weighted portfolio of USD bonds, and so on.

The validity of the instrument is based on two main aspects. First, contemporaneous holdings of US investors at the fund level are exogenous. This follows from the evidence that institutions have asset investment universes which are pre-determined by their investment mandates and therefore exogenous to demand shocks (see Koijen and Yogo (2019) in the case of the US stocks and Bretscher et al. (2020) in the case of US corporate bonds). Second, there is heterogeneity in the investment universe across investors. Bretscher et al. (2020) shows that the investment universe is typically a relatively small set of bonds for US investors at the fund level. This heterogeneity is particularly pronounced between euro area investment funds and US investors. Specifically, 45% of euro area investment funds' USD bonds holdings were issued by non-US issuers. This is in contrast to the share of US mutual funds', life insurance companies', and the Federal Reserve's USD bond holdings issued by non-US issuers which stands at 10%, 15% and 0%, respectively.

For the USD Libor, we use, following Romer and Romer (2004), cumulative surprises in the Libor rate as instruments. Following Gertler and Karadi (2015), we derive high-frequency surprises in the USD measured within a tight window of 30 minutes around the FOMC announcements. This approach aims to ensure that the surprises in the Libor rate solely reflect news about monetary policy decisions and not any other news.

5.3 Baseline estimation

Table 2 reports the estimation results. Columns (1) and (2) report the results for the estimation of the model using the bonds' yields to maturity while Columns (3) to (4) those for estimations of the model using the bonds' credit spreads. We estimate the model once with the instrumented level of USD Libor rate (columns (1) and (3)), and once with time-fixed effects and thus excluding the level of the interest rate (columns (2) and (4)).

The estimated coefficient on the US dollar Libor is significantly negative, with statistical significance at the 1% level. This is in line with the notion that tightening US monetary policy makes USD bonds less attractive for euro area investors as this erodes their yield advantage. At the same time, the demand for a given USD bond by euro area investment funds is significantly positively related the product of the yield to maturity (respectively the credit spread) of that bond and the USD Libor. This means that tighter US monetary policy tend to push up the demand of euro area institutional investors for higher yielding USD bonds. The interaction term is positive and statistically significant at the 1% level irrespective of whether we include the level of the USD Libor rate or time fixed effects in the estimation.

The estimated effect of the yield to maturity (credit spread) of the bond on bond holdings is ambiguous. It is negative when the level of USD Libor rates are included and positive when the model is estimated with time fixed effects. This could reflect a systematic positive link between the level of US interest rates and corporate credit spreads via the classical risk-taking channel of monetary policy. For this reason, we focus in the following on the specification with time-fixed effects.

In Table 2 we also report two tests for weak instruments from the first-stage regressions of the IV estimation of model. We report the multivariate Cragg and Donald (1993) statistic as well as the Kleibergen and Paap (2006) test statistic which is robust to heteroskedasticity and autocorrelation of the error terms. Both tests suggest that the null of weak instruments is comfortably rejected.[14]

The results thus support our prior conceptual considerations. Tighter US monetary policy has a negative direct effect on USD bond holdings through higher hedging costs. This effect is weaker the higher the credit spread of the bond, reflecting reaching for yield through rebalancing toward riskier bonds. Quantitatively, the results suggest that a 100 basis points monetary tightening increases euro area investor portfolio allocation to a USD bond with the median yield to maturity of bonds held by euro area investors (4.01 % from Table 1) by about 0.004 percentage points in terms of portfolio weight. Given that euro area investment funds managed around $ 5.5 trillion of bonds at the end of 2019, this translates into a reallocation of $ 220 million in absolute terms. For the bond in the upper decile of the distribution with a yield to maturity of 6.93%, the allocation increases by about 0.007 percentage points in terms of portfolio weight and $ 381 million in absolute terms.

5.4 Robustness checks

We consider a number of alternative specifications of the USD bond demand system to assess robustness of our findings.

First, we re-estimate the model given by equation 8 using the 3-month EUR/USD swap rate instead of the 3-month USD Libor rate to capture changes in the overall cost of currency hedging. As for the USD Libor rate, we instrument the swap rate using cumulated high frequency monetary policy

[14] We test the significance of the test statistic based on the critical values provided by Stock and Yogo (2005) which vary between 3.63 and 7.03. These critical values are only available for the case of up to two endogenous regressors, so we can only do an approximate evaluation of instrument strength for the specifications with three endogenous variables, i.e. the specification that includes the USD Libor rate. We do so by using the critical values for the case of two endogenous regressors, which represents a more conservative test as the critical values tend to decline with the number of endogenous regressors. That said, the unavailability of critical values to assess instrument weakness in the case of three endogenous regressors provides another reason for focusing on the specification with time fixed-effects and hence only two endogenous regressors.

shocks for both the U.S. and the euro area. We use high-frequency surprises in the USD and Euro Libor rates measured within a 30 minutes window around the FOMC and the ECB monetary policy announcements.

The estimation results reported in Table 3 are in line with our baseline estimates. The demand for a given USD bond by euro area investors is significantly positively related to the interaction of the yield to maturity (respectively the credit spread) of the bond and the EUR/USD swap rate. This means that higher hedging costs tend to push up the demand of euro area institutional investors for higher yielding USD bonds.

Second, we re-estimate the demand system replacing the 3-month USD Libor rate with the hedged yield on the 10-year US Treasury bond (calculated using a rolling 3-month EUR/Dollar swap rate) in order to capture *both* the changes in the overall cost of currency hedging and US Treasury bonds supply factors. As before, we use cumulated high-frequency monetary policy shocks for both the U.S. and the euro area, derived as described in the previous paragraph. For the interpretation of the results, we need to bear in mind that the hedged yield decreases when hedging costs go up, so the expected sign of the interaction with the yield to maturity and the credit spread of a bond is now negative. The estimation results reported in Table 4 are again in line with our baseline findings. The demand for a given USD bond by euro area investors is significantly negatively related to the interaction of the yield to maturity (respectively credit spread) of that bond and the hedged yield on the 10-year US Treasury. This means that lower hedged yield on US Treasury bonds tends to push up the demand of euro area institutional investors for higher yielding USD bonds.

Third, we restimate the model measuring reaching for yield through credit spreads excluding US Treasury bonds which have a zero credit spread. We do so also including all previous robustness checks, i.e. we estimate the model interacting the credit spread of the bond with the USD Libor, the EUR/USD swap rate and the hedged US Treasury yield. The results reported in Table 5 suggest that the results are robust to excluding the zero-credit spread Treasury bonds from the estimations.

6 Price effects of reaching for yield

In this section, we investigate how reaching for yield by euro area investors affects prices in the USD bond market. The results of the previous section imply that a US monetary tightening spurs an increase in euro area investors' *relative* demand for USD bonds with higher yields. This would be expected to create upward price pressure on these bonds relative to the rest of the market.

To test this hypothesis, we examine the path of abnormal bond returns around euro area investors' purchases. We run the following regression using a framework similar to Chodorow-Reich et al. (2020):

$$ret_{i,t} = \beta_{1,i}\, EAbuy_{i,t} + \beta_{2,i}\, EAbuy_{i,t} \cdot y_t^{\$} + \alpha_i + \alpha_t + \epsilon_{i,t} \tag{14}$$

$ret_{i,t} = \frac{P_{i,t}}{P_{i,t-1}}$ where the $P_{i,t}$ is the bond price at the of end of quarter t. $EAbuy_{i,t}$ is an indicator variable which equals one if euro area investment funds bought bond i in quarter t and $y_t^{\$}$ is the 3-month USD Libor instrumented with high-frequency monetary policy shocks as before. All regressions include bond fixed effects denoted by α_i and time fixed effects denoted by α_t. The key coefficient of interest is $\beta_{2,i}$, the coefficient on the interaction term $EAbuy \cdot y_t^{\$}$. This coefficient captures the additional difference in abnormal returns as a result of a change in the stance of US monetary policy. If reaching for yield by euro area investors in the wake of a US monetary tightening creates upward price pressure, then this coefficient would be positive.

The results displayed in Table 6 suggest that bonds purchased by euro area investment funds during quarters with monetary policy tightening exhibit significant positive abnormal returns. Specifically, a one percentage point tightening in the 3-month US dollar Libor rate increases the quarterly abnormal returns of bonds bought by euro area investment funds by about 20 basis points reflecting greater buying pressure by these investors when US monetary policy is tighter. This is primarily driven by lower-rated USD bonds as the results in Table 6 show that the interaction is instead negative for the AAA/AA/A-rated USD bonds, reflecting lower buying pressure exerted by euro area investment funds on bonds in these rating categories when monetary policy is tightened. The interaction is also negative but with no statistical significance for the BBB-rated USD bonds. This finding is consistent with the results in sections 4 and 5 that tighter US monetary policy tends to push up the demand of euro area institutional investors for higher yielding USD bonds and down for lower yielding USD bonds.

We next assess whether these abnormal returns reflect euro area investors bringing information to the market rather than exerting price pressure, following the approach of Coval and Stafford (2007). Specifically, we look for evidence of price reversals by estimating the impact of euro area investor bond purchases and its interaction with US monetary policy in the quarters around the purchases. To this end, we estimate equation 14 with the dependent variable varying from t - 2 to t + 2.

The coefficients on the interaction term $EAbuy \cdot y_t^{\$}$ are plotted in Figure 6. They show an inverted V shaped pattern centering on the quarter of the euro area investors' purchase. This indicates that the abnormal returns reverse over the quarters that follow the bond purchase. Thus, during quarters with tighter US monetary policy, there is upward price pressure from euro area investors' buying of USD bonds. The effect dissipates in the following quarters suggesting that the purchase did not bring additional information to the market.

7 Conclusion

In this paper, we highlight significant deviation of foreign (non-USD-based) institutional investors' behaviour from the classical risk-taking channel operating through domestic (USD-based) investors. We find that euro area investment funds rebalance their portfolio toward USD bonds with higher yields and higher credit spreads when US monetary policy is tightened, reflecting a hedging channel of monetary policy. This hedging channel works in the opposite direction of the classical risk-taking channel for domestic investors, which is associated with less reaching for yield when monetary policy is tightened. This implies that the hedging channel may dampen the transmission of US monetary policy to the USD bond markets and thereby to US financial conditions.

The results of our analysis also point to a new amplifying mechanism in the USD bond market that may have played out during the policy tightening in 2022. When the Federal Reserve tightens monetary policy and the yield curve flattens or perhaps even inverts, this induces foreign investors to re-balance their bond portfolio away from Treasuries as their hedged return decreases. This, in turn, can lead to selling pressure in the USD bond market, especially if it is accompanied by monetary policy normalization by other central banks leading to higher yields outside the U.S. (higher r_e in our framework in Section 3) as observed in 2022. Euro area investors' holdings of USD bonds decreased by $33 billion in 2022 out of which 90% was attributed to euro area investment funds. This has probably contributed to the deterioration of the liquidity and market depth in the Treasury market.

Finally, the analysis of our paper suggests interesting avenues for future research. In particular, our framework could be applied to analyze the extent to which other foreign investors, especially large East Asian (Japan, Korea, Taiwan) institutional investors, shift the composition of their USD bond holdings in response to changes in US monetary policy. East Asian institutional investors' combined share of the market rose from 8 percent in 2013 to 11 percent in 2018 (Breuer et al. (2019)). However, the main challenge in performing this analysis remains the availability of security-level data at the holder sectoral level, similar to the ECB SHSS.[15]

[15] Consistent with the hedging channel outlined in this paper, Bank of Japan (2022) states that "as for currency-hedged foreign securities, due to a rise in U.S. dollar hedging costs, life insurance companies have sold some of their U.S. Treasuries and shifted their investment to higher yield products such as U.S. corporate bonds and European government bonds. Even with the depreciation of the yen, life insurance companies' attempt to increase their exposure to foreign exchange risk has been limited. Currency hedge ratios of their foreign securities investment have remained flat."

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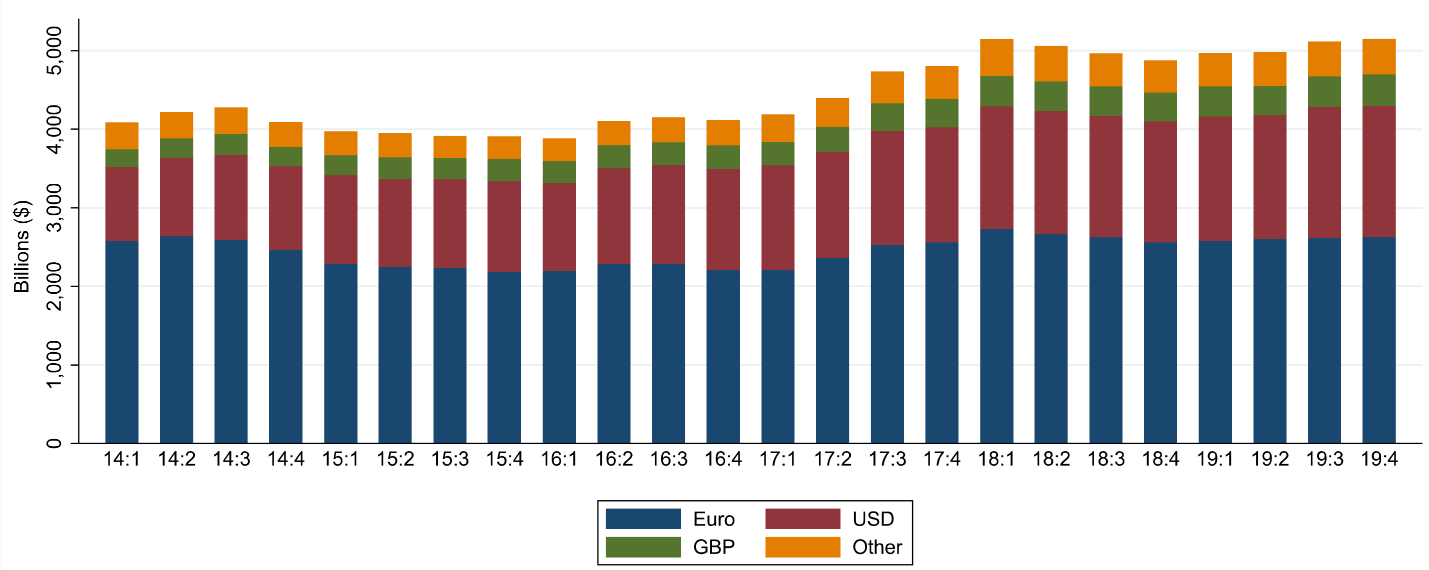
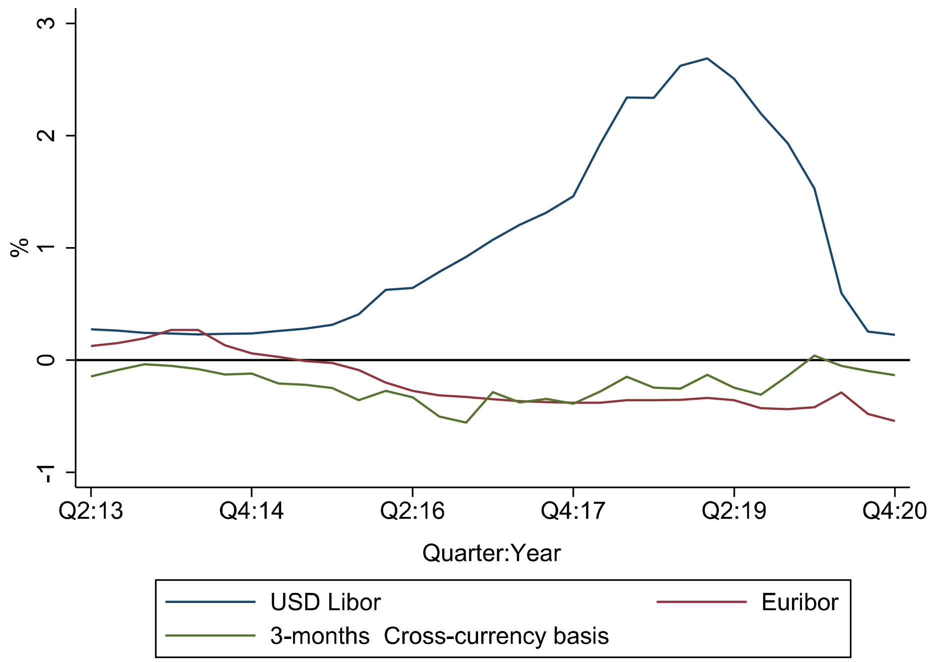
Figure 1: The breakdown of euro area investment funds' bond holdings



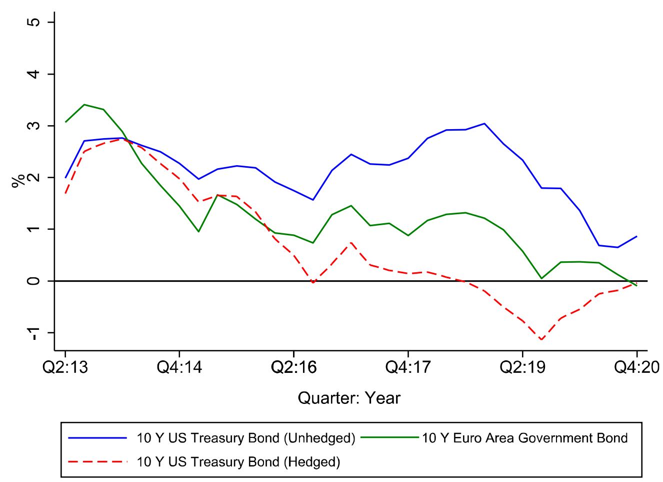
This figure plots the total bond holdings of euro area investment funds grouped by currency. The sample period is from 2014:Q1 to 2019:Q4. The asset holdings are in USD billions.

Figure 2: Factors affecting hedging costs

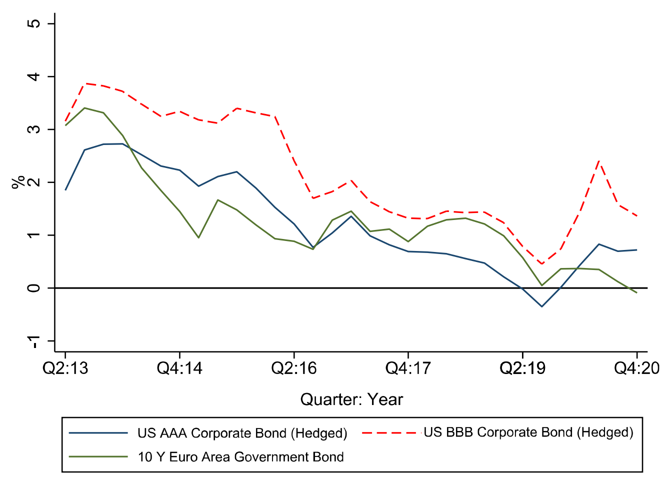


This figure plots the 3-months USD Libor rate, the 3-months Euribor and the three-month Libor cross-currency basis, measured in percentage points for euro/dollar. The data is on quarterly basis from 2013:Q2 to 2020:Q4. The data source of the Libor rates is the Federal Reserve Bank of St. Louis, that of the cross-currency basis is Bloomberg.

Figure 3: US dollar bond yields for euro area investors



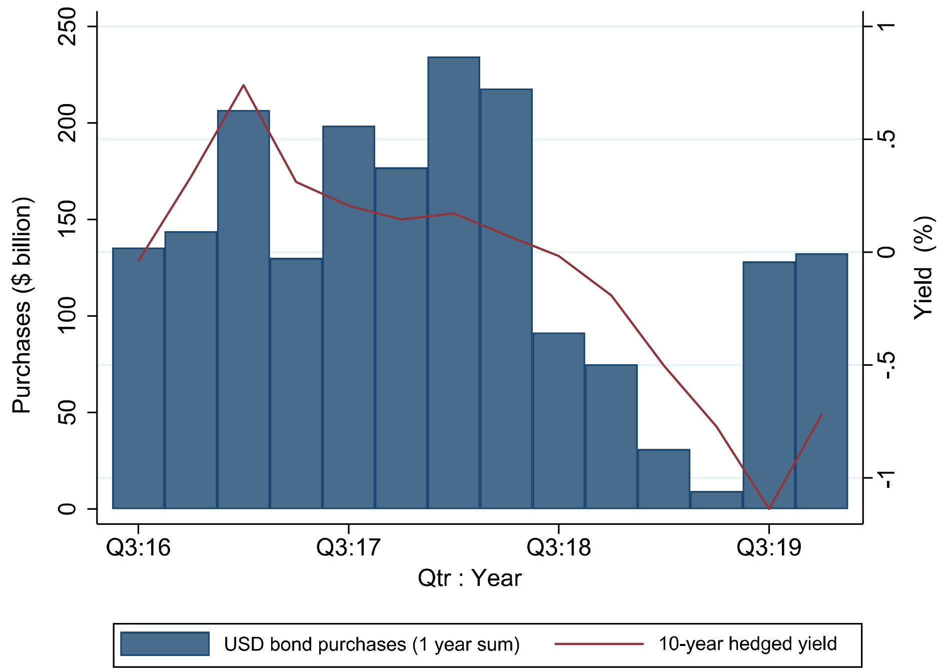
(a) US Treasury bonds



(b) US Corporate bonds

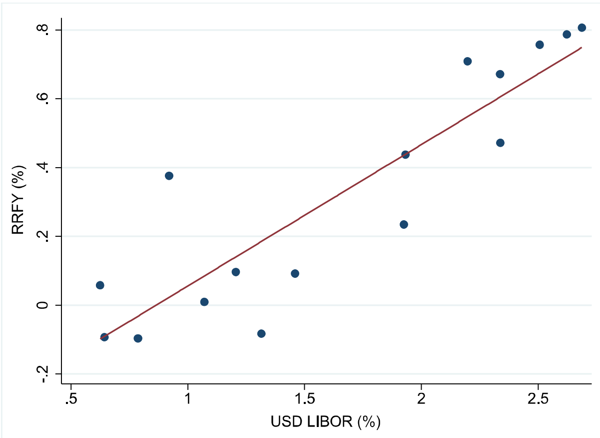
This figure shows the yields on USD bonds for euro area investors. Panel (a) plots respectively the unhedged and hedged yields of the 10-year US Treasury bond and the synthetic euro area 10-year government benchmark bond yield. Panel (b) plots the unhedged and hedged yields of the US corporate bonds by credit rating. The yields are ICE BofA AAA and BBB effective yields. In both panels, hedged yields assume a rolling three-month Euro-Dollar cross-currency swap hedge. The hedged yield is therefore the effective yield minus the 3-month Euro-Dollar swap rate. The date source for the returns of the 10-years Treasury bond and the corporate indices effective yields is the Federal Reserve Bank of St. Louis. The data source for the euro area 10-year government benchmark bond yield is the European Central Bank - Statistical Data Warehouse. The data source for the swap rate is Bloomberg.

Figure 4: Hedged US Treasury yield and US dollar bond flows of euro area investment funds

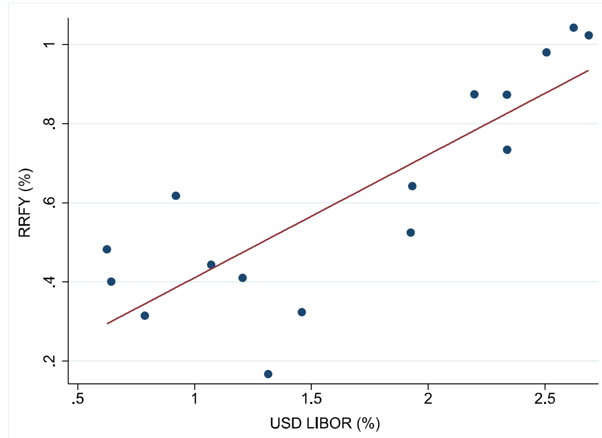


This figure plots the hedged yield on the 10-year US Treasury bond based on a rolling 3-month EUR/Dollar swap measured in percentage points (red line) and the USD bond purchases by euro area investment funds in over a rolling 12-month period measured in billions of dollars (blue bars). The data is on quarterly basis from 2016:Q3 to 2019:Q4. The date source for the hedged yield is the Federal Reserve Bank of St. Louis and Bloomberg. The data source for the USD bond purchases of euro area investment funds is the ECB SSHS.

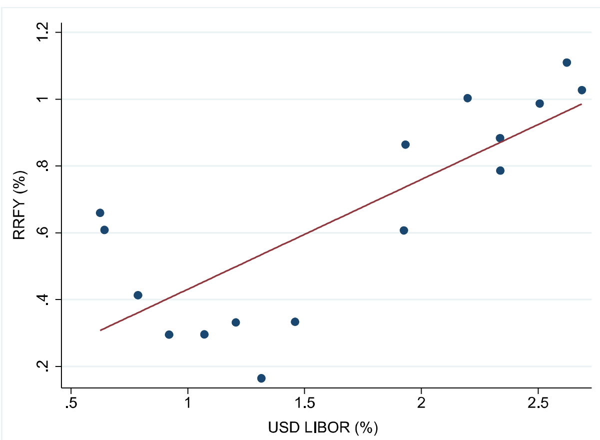
Figure 5: Euro area investment funds' reaching for yield in the USD bond market and short-term US interest rates



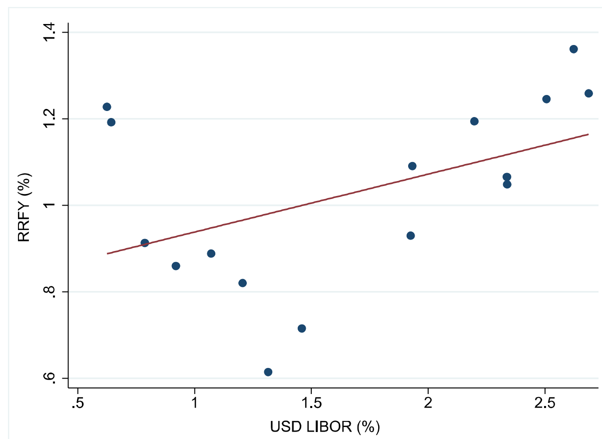
(a) US Mutual Funds - YTM



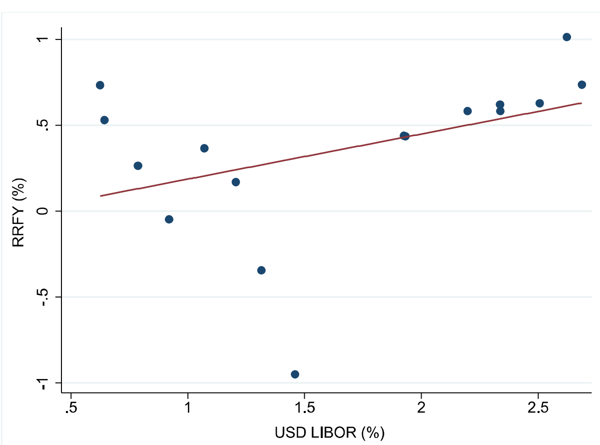
(b) US Mutual Funds - Credit Spreads



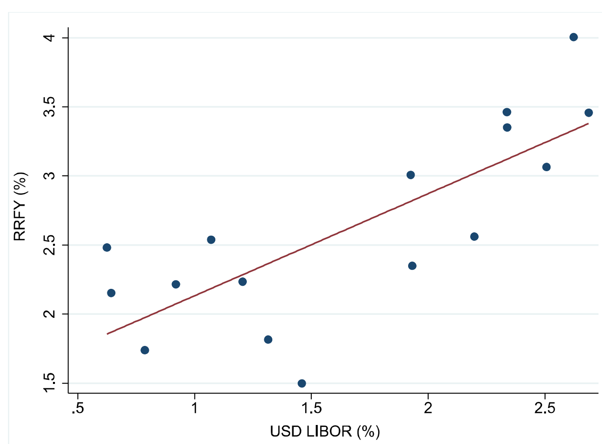
(c) US Life Insurers - YTM



(d) US Life Insurers - Credit Spreads



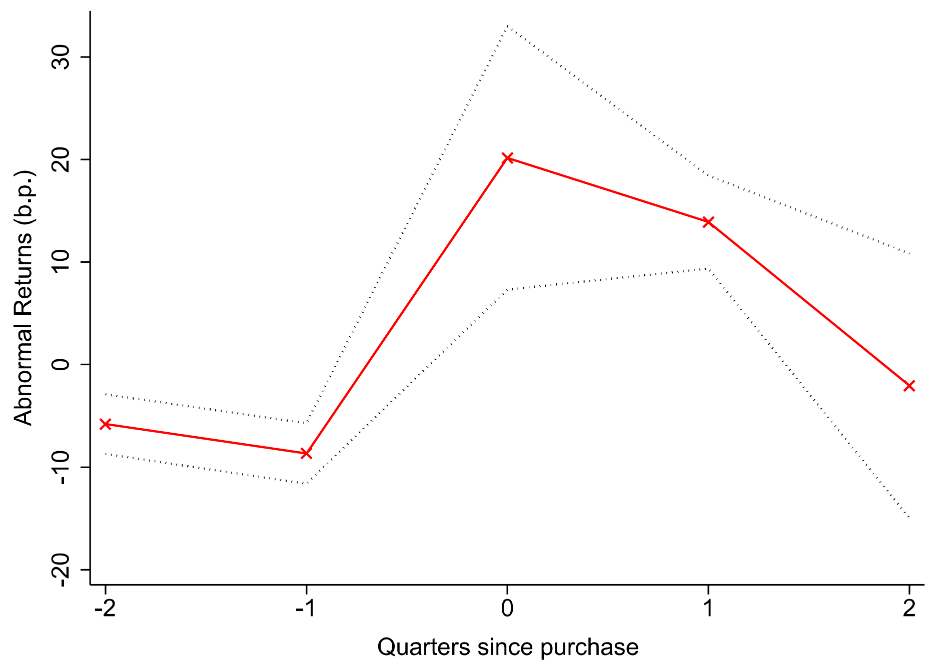
(e) Market - YTM



(f) Market - Credit Spreads

The figure plots the relative reaching for yield (RRFY) measure defined in equations 6 and 7 against the 3-month USD Libor. The upper panel uses the weighted average yield to maturity and credit spread of the US mutual funds sector USD bond portfolio. The middle panel uses the weighted average yield to maturity and credit spread of the US life insurance sector USD bond portfolio. The lower panel uses the weighted average yield to maturity and credit spread of the aggregate USD bond portfolio outstanding in the market as the benchmark. The sample period is from 2016:Q1 to 2019:Q4.

Figure 6: Abnormal return around euro area investment funds' USD bond purchases



This figure plots the coefficients on the interaction term EAbuy · US dollar Libor from the regression in equation 14. The coefficients reflect the effect in basis points. The quarterly sample period is from 2016:Q1 to 2019:Q4. Dotted lines represent 95% confidence intervals on the point estimates for each horizon based on standard errors clustered by issuer and time.

Table 1: Summary statistics by investor type

	Mean	Std. Dev.	10th	50th	90th	N
Euro Area Investment Funds:						
Yield to Maturity (%)	4.24	2.78	0.98	4.01	6.93	574486
Credit Spread (%)	1.91	2.72	0.00	1.56	4.48	574486
Time to Maturity (Years)	13.65	9.26	2.13	13.48	27.15	574486
Amount Outstanding (€ Billions)	2.24	12.9	0.10	0.47	3.07	570482
US Mutual Funds:						
Yield to Maturity (%)	4.72	5.76	0.17	4.10	7.00	1346022
Credit Spread (%)	2.36	5.72	0.00	1.67	4.50	1297155
Time to Maturity (Years)	15.51	9.45	2.92	16.18	27.27	1346018
Amount Outstanding (€ Billions)	0.30	14.3	0.0001	0.14	0.47	1331341
US Life Insurance Companies:						
Yield to Maturity (%)	3.90	3.22	0.11	3.90	6.37	1234928
Credit Spread (%)	1.54	3.19	0	1.47	3.85	1182194
Time to Maturity (Years)	16.01	9.46	3.21	16.75	27.59	1234928
Amount Outstanding (€ Billions)	0.30	1.5	0.0001	0.013	0.45	1217257

Notes: This table summarizes quarterly bond-level statistics for euro area investment funds, US mutual funds and US life insurance companies. Yields to maturity and credit spreads are winsorized at the top 1% level. The data source for the euro area investors' holdings is the ECB Sectoral Securities Holding Statistics (SHSS). The data source for the US life insurance companies and mutual funds' holdings is eMAXX. Bond characteristics, returns and yields are from the ESCB's Centralised Securities Database (CSDB). The sample period is from 2016Q1 to 2019Q4.

Table 2: Estimated USD bond system for euro area investment funds

	(1)	(2)	(3)	(4)
YTM $\cdot$ y$^{\$}$	0.0005***	0.001***		
	(6.16)	(3.26)		
$y^{\$}$	-0.0033***		-0.0029***	
	(-7.25)		(8.81)	
YTM	-0.0021***	0.0018**		
	(-7.05)	(2.44)		
CS $\cdot$ y$^{\$}$			0.0007***	0.0012***
			(5.50)	(3.03)
CS			-0.0023***	0.0018**
			(-5.63)	(1.99)
Number of observations	531,012	531,012	531,012	531,012
Number of issuers	15811	15811	15811	15811
Bond FE	YES	YES	YES	YES
Time FE	NO	YES	NO	YES
Cragg-Donald F-statistic	266.2	71.12	61.57	62.70
Kleibergen-Paap F-statistic	30.25	11.39	9.00	10.42

Notes: This table reports the results from estimating the security-level demand system for euro area investment funds for all USD bonds. The dependent variable is the portfolio weight of the USD bond i at time t, relative to the total bond holdings of euro area investment funds. YTM is the yield to maturity of the bond. CS is the credit spread of the bond calculated as the bond yield spread over a Treasury bond with similar maturity. $y^{\$}$ is the 3-month USD Libor rate. The quarterly sample period is 2016Q1 to 2019Q4. The yield to maturity is winsorized at the top 1% level. The Cragg-Donald and Kleibergen-Paap F statistics test the null hypothesis of weak instruments, with critical values varying between 3.63 and 7.03. Robust standard errors are clustered at the bond issuer level and the corresponding t-statistics are reported in parentheses. The symbols ***, **, and * indicate significance levels of coefficients at the 1%, 5%, and 10%, respectively.

Table 3: Euro area investment funds' USD bond allocations and hedging cost

	(1)	(2)
YTM · Swap	0.0007***	
	(2.71)	
YTM	0.0016**	
	(2.17)	
CS · Swap		0.0008**
		(2.25)
CS		0.0016*
		(1.79)
Number of observations	531,012	531,012
Number of issuers	15811	15811
Bond FE	YES	YES
Time FE	YES	YES
Cragg-Donald F-statistic	94.04	85.68
Kleibergen-Paap F-statistic	13.88	13.01

Notes: This table reports the results from estimating the security-level demand system for euro area investment funds for all USD bonds replacing the USD Libor with the EUR/USD swap rate. The dependent variable is the portfolio weight of the USD bond i at time t, relative to the bonds total holdings by euro area investment funds. CS is the credit spread of the bond calculated as the bond yield spread over a Treasury bond with similar maturity. $Swap$ is the 3-month Euro-Dollar swap rate. The quarterly sample period is 2016Q1 to 2019Q4. The yield to maturity is winsorized at the top 1% level. The Cragg-Donald and Kleibergen-Paap F statistics test the null hypothesis of weak instruments, with critical values varying between 3.63 and 7.03. Robust standard errors are clustered at the bond issuer level and the corresponding t-statistics are reported in parentheses. The symbols ***, **, and * indicate significance levels of coefficients at the 1%, 5%, and 10%, respectively.

Table 4: Euro area investment funds' USD bond allocations and US Treasury hedged return

	(1)	(2)
YTM · Hedged	-0.0007***	
	(-2.97)	
YTM	0.0026***	
	(3.66)	
CS · Hedged		-0.0007**
		(-2.52)
CS		0.0027***
		(3.52)
Number of observations	531,012	531,012
Number of issuers	15811	15811
Bond FE	YES	YES
Time FE	YES	YES
Cragg-Donald F-statistic	107.4	92.20
Kleibergen-Paap F-statistic	15.77	14.19

Notes: This table reports the results from estimating the security-level demand system for euro area investment funds for all USD bonds replacing the USD Libor with the hedged 10-year Treasury yield. The dependent variable is the portfolio weight of the USD bond i at time t, relative to the bonds total holdings by euro area investment funds. $Hedged$ is the yield on the 10-year US Treasury bond based on a rolling 3-month EUR/Dollar swap. The quarterly sample period is 2016Q1 to 2019Q4. The yield to maturity is winsorized at the top 1% level. The Cragg-Donald and Kleibergen-Paap F statistics test the null hypothesis of weak instruments, with critical values varying between 3.63 and 7.03. Robust standard errors are clustered at the bond issuer level and the corresponding t-statistics are reported in parentheses. The symbols ***, **, and * indicate significance levels of coefficients at the 1%, 5%, and 10%, respectively.

Table 5: Estimated demand by euro area investment funds: USD bonds

	(1)	(2)	(3)
CS $\cdot$ $y^{\$}$	0.0008***		
	(4.01)		
CS $\cdot$ $Swap$		0.0004**	
		(2.47)	
CS $\cdot$ $Hedged$			-0.0004***
			(-2.76)
CS	0.0014**	0.0014**	0.0020**
	(2.24)	(2.20)	(4.60)
Number of observations	522,855	522,855	522,855
Number of issuers	15805	15805	15805
Bond FE	YES	YES	YES
Time FE	YES	YES	YES
Cragg-Donald F-statistic	59.84	100.68	96.91
Kleibergen-Paap F-statistic	13.26	17.69	15.77

Notes: This table reports the results from estimating the security-level demand system for euro area investment funds excluding US Treasury bonds that have zero credit spread. The dependent variable is the portfolio weight of the USD bond i at time t, relative to the bonds total holdings by euro area investment funds. CS is the credit spread of the bond calculated as the bond yield spread over a Treasury bond with similar maturity. $y^{\$}$ is the 3-month USD Libor rate. $Swap$ is the 3-month Euro-Dollar swap rate. $Hedged$ is the yield on the 10-year US Treasury bond based on a rolling 3-month EUR/Dollar swap. The quarterly sample period is 2016Q1 to 2019Q4. The yield to maturity is winsorized at the top 1% level. The Cragg-Donald and Kleibergen-Paap F statistics tests the null hypothesis of weak instruments, with critical values varying between 3.63 and 7.03. Robust standard errors are clustered at the bond issuer level and the corresponding t-statistics are reported in parentheses. The symbols ***, **, and * indicate significance levels of coefficients at the 1%, 5%, and 10%, respectively.

Table 6: Quarterly abnormal return around euro area investment funds' USD bond purchases

	All	AAA/AA/A	BBB
EA Buy $\cdot$ $y_t^{\$}$	20.16***	-13.33***	-6.69
	(3.07)	(-3.04)	(-0.05)
Buy	-32.47***	21.76***	5.95
	(15.46)	(2.96)	(0.41)
N of Observations	24,879,773	38,292	2,895
Number of Issuers	90970	2454	455
Number of Quarters	16	16	16

Notes: This table reports results for the estimation of Equation 14. $EAbuy_{i,t}$ is an indicator variable which equals one if euro area investment funds bought a bond i in quarter t. $y_t^{\$}$ is the 3-month USD Libor rate instrumented with the cumulative monetary policy shocks to Libor rates. The abnormal return of bond i in quarter t, denoted as $ret_{i,t}$, is calculated as $\frac{P_{i,t}}{P_{i,t-1}}$ where the $P_{i,t}$ is the bond price at the of end of quarter t. It is presented in basis points (bps). Standard errors are clustered around issuers. The symbols ***, **, and * indicate significance levels of coefficients at the 1%, 5%, and 10%, respectively.

Appendix

Implication 1

Taking the first order condition of equation 5 with respect to $y_\$$, we get:

$$\frac{\partial w^*}{\partial y_\$} = \frac{1}{\xi} \cdot \frac{1-\rho-\phi}{S} \tag{15}$$

where $S = C_\$^\alpha + C_e^\alpha + (1-\phi)^2\sigma_f^2 > 0$. The USD bond allocation is decreasing in the US short-term rate if $\frac{\partial w^*}{\partial y_\$} < 0$. This is true for high FX hedge ratio: $\phi > 1-\rho$.

Implication 2

Taking the cross derivative of equation 5 with respect to $C_\$$ and $y_\$$, we get:

$$\frac{\partial w^*}{\partial y_\$} = -\frac{\alpha C_\$^{\alpha-1}}{\xi} \cdot \frac{1-\rho-\phi}{S^2} \tag{16}$$

The higher the US short-term rate, the stronger the demand of USD bonds with higher yields and credit spreads if $\frac{\partial^2 w^*}{\partial C_\$ \partial y_\$} > 0$. This is true for high FX hedge ratio: $\phi > 1-\rho$.