Exchange Rate Reconnect*

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Abstract

It is surprisingly difficult to find economic variables that strongly co-move with exchange rates, a phenomenon codified in a large literature on "exchange rate disconnect." We demonstrate that a variety of common proxies for global risk appetite, which did not co-move with exchange rates prior to 2007, have provided significant in-sample explanatory power for currencies since then. Furthermore, during 2007-2012, U.S. purchases of foreign bonds were highly correlated with these risk measures and with exchange rates. Our results support the narrative that the US dollar's role as an international and safe-haven currency has surged since the global financial crisis.

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1 Introduction

Starting with the influential contribution by Meese and Rogoff (1983), a long literature has demonstrated the difficulty in finding economic variables that co-move with exchange rates, a phenomenon known as "exchange rate disconnect." The paucity of robust empirical relationships between exchange rates and other aggregates offers little guidance for researchers and policymakers on which macroeconomic models to use. While progress has certainly been made, the proverbial glass remains – at the very most – half full.

It is against this backdrop that we uncover a surprising pattern that emerged with the global financial crisis: exchange rates, and in particular the broad US dollar, have co-moved closely with global risk appetite and with U.S. foreign bond purchases. Since 2007, during months when proxies for global risk appetite decrease, the dollar contemporaneously appreciates. When risk appetite increases, the dollar depreciates. Whereas risk measures had little or no explanatory power for exchange rates prior to the crisis, the risk measures statistically explain a meaningful share of all subsequent exchange rate variation. Furthermore, during 2007-2012, U.S. purchases of foreign bonds rose and fell with these measures of global risk appetite, and so these capital flows also co-moved with the broad US dollar. In quarters when U.S. residents increased their holdings of external debt, the dollar contemporaneously depreciated. When U.S. residents decreased these foreign bond holdings, the dollar appreciated.

We dub the emergence of the relationships of global risk proxies and U.S. foreign bond purchases with the exchange rate as "exchange rate reconnect." It is difficult to reach definitive conclusions from such short time series as the 2013-2018 period, but it appears that the risk measures remain reconnected with exchange rates even at the end of our sample. U.S. foreign bond purchases, however, appear to have again disconnected with the broad US dollar.

We start our analysis by examining the connection between exchange rates and common proxies of global risk appetite, including credit spreads, financial intermediary returns, the S&P 500 returns and their implied volatility in option markets, and the premium on U.S. Treasuries. Consistent with Lilley and Rinaldi (2018), who first showed that the S&P 500 and exchange rates began to co-move since the crisis, we demonstrate that all six risk proxies exhibit a structural break around 2007. We run rolling regressions of exchange rates on our risk proxies using monthly data spanning 10- and 5-years. We find negligible explanatory power before the crisis and large R^2s – in some cases, surpassing 50 percent – since then. Even at the end of our sample, the estimated coefficients in these regressions generally remained significantly different from zero and above their pre-crisis values.

We decompose the explanatory power of these risk measures for the broad dollar into its bilateral exchange rate components. Intuitively, the co-movement of these risk measures and bilateral exchange rates between the dollar and other safe-haven currencies such as the Swiss franc and Japanese yen remains fairly muted, even after the crisis. Instead, the reconnect of global risk measures and the broad dollar is largely driven by the bilateral exchange rates between the US dollar and currencies conventionally thought of as riskier, such as the Australian dollar.

Next, we turn to publicly available data from the IMF Balance of Payments (BoP) and International Investment Positions (IIP) to construct quarterly measures of U.S. capital flows. In rolling 10-year and 5-year regressions using these data, quarterly changes in U.S. gross foreign bond flows (as a share of the stock of U.S. foreign bond positions) had near-zero explanatory power for changes in the broad US dollar exchange rate prior to 2007. At the time of the crisis, the correlation between these objects increased and the R^2 on the regressions climbed sharply. The R^2 of the 5-year regressions, after peaking above 50 percent for the period corresponding to 2007-2012, returns to a near-zero level for 2013-2018. We conclude that the connection of U.S. gross foreign bond flows to exchange rates lasted for a number of years when markets were in a heightened state of turmoil.

When we repeat the identical exercise for other countries and for other flow measures (including outflows, inflows, and net flows of bonds, equity, and direct investment), we do not find similarly compelling evidence of reconnect. Since other flows likely interact similarly to U.S. foreign bond flows in terms of the pressure they exert on currency markets and their interaction with various market frictions, and given the continued reconnect of risk measures and exchange rates, we do not view the relationship between U.S. foreign bond flows and the dollar as causal. Rather, we believe fluctuations in global risk appetite simultaneously influenced both exchange rates and U.S. foreign bond flows during the crisis and several years of its aftermath. In this sense, the reconnect carries something of a special role for the United States.

Having demonstrated the strong in-sample explanatory power of U.S. purchases of foreign bonds for the broad US dollar, at least during 2007-2012, we turn to a novel micro dataset capable of elaborating on the mechanics of this reconnect. We use data assembled by Maggiori, Neiman and Schreger (2019a) on mutual fund and exchange traded fund (ETF) holdings from Morningstar that covers $32 trillion of assets from individual security-level positions. These data do not extend backward enough in time to capture the change that occurs around 2007, but they do offer a number of benefits relative to BoP and IIP data.

First, the mutual fund holdings decompose the market value of positions into prices and quantities. As such, we can use them to isolate changes in foreign bond positions that come from purchases of additional securities and not from movements in prices or exchange rates. This ensures that reconnect does not reflect the mechanical influence of the exchange rate on the value of foreign bond purchases. Indeed, even with this conservative notion of flows, U.S. foreign bond flows in the Morningstar data do have a similarly high explanatory power for the broad dollar as we found in the public macro data from 2007 onward.

Second, U.S. purchases of foreign bonds in the Maggiori et al. (2019a) dataset can be separated by issuing country, sector (corporate or government), and currency of denomination. Further, the data can be used to explore these purchases across different kinds of investors, including large versus small mutual funds or those that specialize in international investment versus those that do not. In doing so, we find that the explanatory power of U.S. portfolio flows is driven as much by U.S. net purchases of dollar-denominated bonds as by U.S. purchases of foreign-currency-denominated bonds. This further corroborates that the explanatory power is indeed coming from the relationship between these flows and changes in a global risk factor, rather than from the direct effect of a sale of US dollars and purchase of foreign currencies. In addition, in contrast to BoP data, the Morningstar data allow us to see which securities investors are buying domestically. Consistent with the idea that flows are picking up changes in investors' risk appetite, we see that when U.S. investors buy less U.S. Treasuries or more domestic corporate debt, the dollar depreciates.

Third, we sort the open-end and exchange-traded funds in Maggiori et al. (2019a) according to their size, the degree to which they specialize in foreign investment or foreign currency investment, and the degree to which they follow a passive investment strategy. We find that the aggregate results are driven by large actively-managed funds that are not specialists in foreign currency or foreign issuers. The fund-level analysis therefore also supports the view that U.S. foreign bond flows largely pick up the risk appetite of sizable dollar-centric discretionary U.S. investors.

In summary, we identify the emergence of a close relationship between various global risk measures and the broad US dollar that emerged with the global financial crisis. Further, we identify a particular quantity, U.S. foreign bond purchases, that has strongly comoved with these risk measures and the broad US dollar during the crisis and several years of its aftermath, even though this relationship no longer appears to hold at the end of our data. In the context of the voluminous literature on exchange rate disconnect which offers few comparably successful covariates, we consider this progress even if the post-crisis time series is short and we do not establish a causal mechanism.

Our results are consistent with the narrative that when U.S. residents have a greater risk appetite, they use it to purchase foreign bonds in all currencies and at the same time require a lower risk premium, which causes the world's primary safe-haven currency to depreciate, particularly against riskier currencies. Most theoretical models do not contain all the elements required to study, let alone to fully explain, the phenomena we document and their stark emergence after 2007. An emerging literature has incorporated time variation in the global risk appetite, asymmetries between the United States and other countries, and financial frictions into dynamic models with well-defined nominal exchange rates and cross-border investment flows. We hope our findings serve as motivation for further development of these types of approaches.

Related Literature Our documentation that exchange rate reconnect started around 2007 relates to the finding in Du, Tepper and Verdelhan (2017) of large covered interest rate parity deviations (CIP) over this same period, which Avdjiev, Du, Koch and Shin (2019b) show are systematically related to the dollar exchange rate. More generally, a number of papers have made progress on the exchange rate disconnect puzzle. Gourinchas and Rey (2007) show predictability over medium term horizons using the cyclical component of net external balances, and Kremens and Martin (2018) have success forecasting exchange rates with S&P 500 options-implied risk premia. Measures of the convenience yield on treasuries have been shown to covary with the broad dollar exchange rate in Jiang et al. (2018) and Engel and Wu (2018). Adrian et al. (2010) find that growth in the dollar-denominated liabilities of the banking sector forecasts appreciations of the U.S. dollar, and Adrian and Xie (2019) find that a higher share of US dollar loans in the portfolio of non-U.S. banks forecasts a dollar depreciation. Lustig, Roussanov and Verdelhan (2011) highlight the importance of common factors in explaining the cross-section of exchange rate movements.

Further, the crisis seems to have further cemented the role of the US dollar as the primary global safe asset. Maggiori et al. (2019a,b) document a broad and persistent portfolio shift into dollar-denominated bonds (and away from euro-denominated bonds) since the financial crisis. These latter two developments suggest an increase in the role of risk premia in driving the broad dollar. Our results support an emerging narrative that the US dollar's role as an international and safe-haven currency has surged since the global financial crisis (Bruno and Shin (2015); Jiang et al. (2019); Kekre and Lenel (2020); Cerutti et al. (2019)).

2 Exchange Rate Disconnect and Reconnect

A large literature documents the disconnect between the exchange rate and macroeconomic fundamentals. For example, uncovered interest parity implies a strong relationship between the nominal exchange rate for two countries and the difference in their interest rates. As we demonstrate in Appendix Figure A.1a, however, during 1977-2006, less than 5 percent of the variation in quarterly log-changes in the broad dollar, defined as an equally-weighted basket of nine currencies (the G10, excluding the United States) against the US dollar, is explained by the quarterly interest differential between the United States and those nine other countries. Appendix Figure A.1b similarly demonstrates that changes in observed inflation differentials and the exchange rate over that same period exhibit an even weaker realtionship, at odds with many standard models. Given this much-studied exchange rate disconnect holds in-sample for realized outcomes, it is not surprising that interest rates and inflation differentials, as well as many other economic aggregates, also offer no out-of-sample forecasting power.

2.1 Reconnect with Global Risk Appetite

The reconnect of exchange rates to global risk appetite can be clearly seen in Figure 1, which plots the R^2 values of rolling univariate regressions run in monthly data of the broad dollar exchange rate on a constant and the contemporaneous change in six global risk proxies. These proxies include (i) the "GZ Spread", an index of aggregated U.S. corporate bond spreads constructed by Gilchrist and Zakrajšek (2012) (ii) the "VXO", calculated as the monthly change in the log implied volatility on the S&P100 stock index, (iii) the log total return on the "S&P500", (iv) the "Treasury Premium" constructed as the average one-year covered interest parity deviation between developed country government bonds and U.S. Treasuries taken from Du et al. (2018), (v) the "Global Factor" in world asset prices constructed by Miranda-Agrippino and Rey (2018), and (vi) the "Intermediary Returns" from a value-weighted portfolio of holding companies of New York Federal Reserve primary dealers taken from He et al. (2017). Figure 1a shows regressions estimated on 10-year rolling windows, and Figure 1b considers 5-year windows, starting in January of 1977 and ending in December of 2018.

During 1977-2006, most of the rolling regressions in Figure 1a have R^2s that average only a few percentage points and peak at about 5-10 percent. Around 2007, however, there is an abrupt but sustained increase in the explanatory power of most of these risk proxies for the broad dollar. The measures subsequently have R^2 values ranging from 10 to 60 percent, with most finishing the sample with R^2 values above 20 percent, large values that stand out in the exchange rate disconnect literature. Even after the steep one-quarter declines in the R^2s at the very end of the sample, which arise from dropping the second quarter of 2009 from the rolling regressions, all of the 10-year regressions in Figure 1a have R^2s well above their pre-crisis peak values. The 5-year regressions in Figure 1b similarly have R^2 values that peak between 30-70 percent, though these R^2s also sharply decline toward the end of our sample, suggesting that the explanatory power of global risk measures for the exchange rate was greater during 2007-2012 than during 2013-2018. Nonetheless, four of the six measures, even in this final five-year period of our sample, offer more explanatory power than they did at any point prior to the crisis.

The break from historical experience in the relationship between these risk measures and the broad dollar can be additionally seen by examining the regression coefficients underlying the R^2 values shown in Figure 1b. For each of the six risk proxies, we plot in Figure 2 the point estimates from the rolling regressions along with their 95 percent confidence intervals. In the regressions, a positive coefficient indicates that a depreciation of the broad dollar is associated with a decline in the risk premium (or an increase in risk appetite) captured by our proxies. We plot the estimates after normalizing them as z-scores, so they give the percent depreciation of the broad dollar in response to a one-standard-deviation increase in each measure of risk appetite. For example, the value in Figure 2b corresponding to the GZ Spread ends our sample at 0.0125, implying that when corporate credit spreads drop by one standard deviation, the dollar depreciates by 1.25 percent. In all six cases, the coefficients rise dramatically from their typical pre-crisis values to their post-crisis peaks near 2012, all of which are statistically greater than zero. In four of the six cases, the estimates remain statistically greater than zero, even by the last quarter of 2018, the last observation for these risk measures in our data.

2.1.1 Bilateral Exchange Rates

We can further unpack the exchange rate reconnect of global risk appetite by studying how the risk proxies correlate differently with different bilateral exchange rates. We find that when our measures of the risk premium decrease, the dollar depreciates most strongly against currencies conventionally described as "riskier" and less strongly or not at all against currencies conventionally considered to be "safe havens". Appendix Figure A.2 reports the coefficients from regressions of changes in each bilateral exchange rate against the dollar on changes in the GZ Spread using monthly data from 2007 to 2018. While safe-haven currencies such as the Yen and Swiss Franc hold steady or even depreciate vis-a-vis the US dollar when credit spreads are low (i.e. when risk appetite is high), the emerging market currencies and the New Zealand and Australian dollars appreciate. In fact, as shown in Appendix Table A.1, the different degrees of comovement across bilateral pairs with the US dollar implies that in the post-crisis period, fluctuations in global risk appetite explain significant shares of variation in all bilateral exchange rates. Appendix Table A.2 demonstrates that this was not at all the case before the crisis. Appendix Tables A.6-A.7 and Figures A.7-A.8 examine the loadings and R^2 of each currency to these various measures of risk appetite.

2.1.2 Out-of-Sample Forecasting

As detailed in Appendix A.1, we evaluate the forecasting capabilities of our risk proxies. We follow the tradition established by Meese and Rogoff (1983) in evaluating the "out-of-sample" fit of a model while giving the model the realized values of the regressors. Appendix Figure A.4 and Table A.5 shows our results. Prior to 2007, we find the standard result: all model forecasts based on the risk proxies perform worse, or on par at best, with a random walk. Yet for the last decade, we find that all of these models outperform the "no-change" benchmark.

2.2 Reconnect with U.S. Foreign Bond Purchases

The post-crisis reconnect between global risk measures and exchange rates is strong, appears long-lived, and complements a small number of recent successes in the exchange rate forecasting literature that use other price-based variables. The finding of reconnect between quantity-based macroeconomic aggregates and exchange rates, however, has been even more elusive. In this section we demonstrate that U.S. purchases of foreign bonds, a type of U.S. capital flow, strongly comoved with these risk measures and, therefore, strongly moved with the broad dollar during 2007-2012.

We start by constructing U.S. purchases of foreign bonds as the quarterly flow of U.S. funds into foreign debt securities (from BoP) divided by the value of U.S. foreign debt holdings at the start of the quarter (from IIP). During 2007-2012, in a clear break from the pre-crisis relationship, these U.S. purchases of foreign bonds moved closely together with each of the six risk measures.[1] Further, we find that the comovement of this U.S. capital flow and our risk measures led to the reconnection of U.S. foreign bond purchases and the broad dollar over this period.

Figure 3a shows the R^2 of 10- and 5-year rolling regressions of the broad US dollar and U.S. foreign bond purchases and demonstrates that the answer is yes. The series estimated with rolling 10-year windows, plotted in a solid black line, shows that the explanatory power of changes in these bond flows for changes in the broad dollar jumps from near-zero to about 15 percent with the onset of the crisis and peaks near 40 percent shortly thereafter. The removal of the first post-crisis quarter from the estimation window causes a steep decline for the last plotted value, but the level even at the end of our series remains clearly elevated relative to pre-crisis values. The 5-year series, plotted with a red dashed line, shows an even greater surge in the explanatory power of these bond flows for the broad dollar during the period from 2007-2012, though the R^2 values return by the end of the sample to negligible levels. We do not wish to draw definitive conclusions based on 5-year windows, but the results do suggest that the reconnect of U.S. foreign bond purchases and the broad dollar did not persist through the end of our sample.

Much of the stark change in Figure 3a is driven by the particularly large appreciation of the US dollar and particularly large reduction in U.S. foreign bond holdings during the third and fourth quarters of 2008. The confluence of reconnect of this capital flow and the global financial crisis is important and intriguing. We emphasize, however, that the large movements during 2007-2009 are not wholly responsible for reconnect. To give a better sense for how evenly distributed reconnect is across the post-crisis period, Figure 3b plots the change in flows against the change in the broad dollar for each quarter of 2007:Q1-2019:Q2 in a scatterplot. The solid black best-fit line has a positive slope of 0.85 that indicates that greater U.S. purchases of foreign bonds are associated with larger depreciations of the US dollar and the R^2 on this relationship between the broad dollar and U.S. purchases of foreign bonds equals 32 percent. The red dashed line in Figure 3b demonstrates that the best-fit slope relating these two variables is nearly identical whether including or excluding 2007:Q1 to 2009:Q2, the key quarters of the global crisis.[2]

[1] Appendix Figures A.5a and A.5b report the R^2 of rolling 10-year and 5-year univariate regressions of quarterly changes in U.S. holdings of foreign bonds on the six risk measures. All series jump starting in 2007, though the R^2s from the 5-year regressions all also sharply decline after 2013.

[2] Appendix Figure A.1d offers an equivalent plot of pre-crisis quarters and has an R^2 of less than one percent.

2.2.1 Other U.S. Capital Flows?

Interestingly, other types of U.S. capital flows have not exhibited a post-crisis reconnect with global risk measures nor with the broad dollar.[3] Appendix Table A.3 reports regression estimates for gross foreign purchases, gross foreign sales, and net foreign purchases by the United States of bonds and of equities. Of these six types of U.S. capital flows, only U.S. gross foreign purchases of debt securities and U.S. gross sales of equities exhibit a meaningful post-crisis change in their explanatory power for the broad dollar, with the change for U.S. foreign bond purchases being the largest by far.[4]

2.2.2 Other Macroeconomic Fundamentals

In Appendix Figure A.6 and Appendix Table A.4, we analyze whether there has been a reconnect of other macroeconomic fundamentals to exchange rates. We run 40-quarter and 20-quarter rolling-window regressions using the fundamentals that are related to exchange rates in several standard models in international economics, analogous to what we did with global risk measures in Figure 1. Guided by the excellent review of exchange rate predictability in Rossi (2013), the models that we test include the UIP model, the monetary model, the Taylor-rule model, and the Backus-Smith model.[5] While most models perform relatively poorly, it is not unusual to find short spans of data over which a particular model works well. Relative to these other macro fundamentals, the relationship between U.S. foreign bond purchases and the broad dollar during 2007-2012 is clearly sharper and more persistent. Nonetheless, these appendix analyses remind us of the need for caution in reaching too strong conclusions from short time series.

In sum, before the global financial crisis of 2007-2008, exchange rates rarely comoved with other economic aggregates. We demonstrate, however, that several common proxies for global risk appetite, and even more surprisingly, U.S. purchases of foreign bonds, strongly reconnected with the broad dollar starting around 2007. Reconnect remains even after excluding the quarters of the global financial crisis, though it has significantly attenuated in recent years. The short time series cautions against definitive conclusions, but at the end of our sample, risk-based reconnect appears

[3] We do not offer a theory of why some flows have reconnected while others have not. We hope our empirical results might offer further guidance on the source of these shocks. For example, recent models such as Farhi and Werning (2014) and Itskhoki and Mukhin (2017) have introduced financial shocks in the Euler equations for foreign currency bonds.

[4] The importance of the distinction between gross and net capital flows has been documented empirically by Forbes and Warnock (2012), Broner et al. (2013), and Avdjiev et al. (2018). An interesting literature studies the relationship between bank credit and exchange rates, including Avdjiev et al. (2019b,a), Miranda-Agrippino and Rey (2018), and Niepmann and Schmidt-Eisenlohr (2019)).

[5] Appendix A.2 provides details about the implementation of each model. Recent contributions of this literature include Engel and West (2005), Chen et al. (2010), Eichenbaum et al. (2017), Schmitt-Grohé and Uribe (2018), and Calomiris and Mamaysky (2019).

to continue while we no longer see evidence for capital-flow-based reconnect.[6]

3 Elaborating Reconnect with Micro Data

One key benefit of our finding that a type of U.S. capital flow began to co-move with the broad dollar is that it offers a natural pathway to explore reconnect further. In particular, we can disagregate those capital flows using the security-level holdings details assembled by Maggiori et al. (2019a) using Morningstar data on open-end mutual fund positions.[7] These data cover $32 trillion of assets and allow us to make two distinct contributions. First, our micro data allow us to directly disentangle security purchases from changes in security prices, whereas BoP or IIP data necessarily conflate the two to some degree when calculating changes in positions. This means that we can confirm that our finding that flows correlate with exchange rates is not a mechanical effect from using exchange rates to measure these flows. Second, the micro data allow us to study reconnect using various subsets of the data, distinguishing flows by currency, asset class, and investor type, for example.[8] In this final section of the paper, therefore, we use these micro data to unpack the reconnect of exchange rates with U.S. foreign bond purchases.

3.1 Reconnect after Separating Purchases from Price Changes

Our previous analyses defined flows as quarterly purchases of foreign securities during a quarter divided by the stock of holdings of such securities at the start of the quarter. Aggregated data on these purchases, however, do not allow us to completely separate the quantity of securities purchased and the price at which they were purchased. The flow measures might therefore contain information about the exchange rate, since it may be an important driver of the security's price (particularly if the security is not dollar-denominated). For claims such as ours, that a macroeconomic variable co-moves with the exchange rate, this limitation is critical.

We circumvent this issue in this section by building a measure of flows that keeps all prices and exchange rates constant at their beginning-of-quarter levels, which we are able to do using the dataset assembled by Maggiori et al. (2019a). These data capture the detailed holdings of all U.S. mutual funds and ETFs and allow us to separately track for each position s at the end of each quarter

[6]All results presented in this section can be easily replicated using the code and datasets posted to `http://www.globalcapitalallocation.com`.

[7]We refer the reader to Maggiori et al. (2019a) and its Online Appendix for an extensive study of the representativeness of this type of flows for the BoP. Here, we only note that the measured changes in U.S. holdings of foreign bonds in the two sources have a correlation of 0.64. Appendix Figure A.3 plots the two time series from 2005:Q1 to 2017:Q4, the maximum span we can study in the micro data.

[8]We follow the procedure in Coppola et al. (2019) to classify positions based on nationality of the ultimate parent and not residency of the immediate issuer. The BoP and IIP are instead based on residency.

t the number of securities $N_t(s)$ and the price per security $P_t(s)$. The total start-of-quarter value of the position is then simply the product of the two at the end of the prior quarter: $Q_{t-1}(s) = P_{t-1}(s) \times N_{t-1}(s)$, while the flow is the change in the number of securities during the current quarter times the start-of-quarter price: $F_t(s) = (N_t(s) - N_{t-1}(s)) \times P_{t-1}(s)$. We can then aggregate the flows across all positions s within some category S (such as corporate or government bonds, denominated in dollars or otherwise), $F_{t,S} = \sum_{s \in S} F_t(s)$, and divide the total by the aggregated start-of-quarter positions, $Q_{t-1,S} = \sum_{s \in S} Q_{t-1}(s)$, to construct a measure equivalent to what we studied using aggregated data above, $F_{t,S}/Q_{t-1,S}$.

In Appendix Table A.8, we confirm that U.S. foreign bond purchases constructed from these micro data connect with the broad US dollar to a similar extent as did these purchases when taken from the macro data. While the coefficients are slightly different, the R^2 are quite close: 33 percent for the BoP and 39 percent for the Morningstar data.

3.2 Which Flows Matter?

As discussed above, we believe the post-crisis era has been characterized by a reconnect between the exchange rate and proxies for global risk appetite. Unique among the set of flows we examined, U.S. purchases of foreign bonds appear to have themselves started to comove with these risk proxies, which brought about our capital-flow-based reconnect.

One might find it natural that bonds are more connected to exchange rates than equities since bonds are promises to pay units of a particular currency and equities are claims on real assets. Therefore, one might conjecture that the connection between U.S. foreign bond flows and the broad dollar occurs because U.S. residents are changing their positions in foreign-currency bonds, thus directly and causally affecting the exchange rate as in portfolio balance models of exchange rate determination.[9] Panel A of Table 1 shows that this is not the case. Much of the information about the exchange rate contained in U.S. purchases of foreign bonds is contained in U.S. purchases of foreign, but US dollar-denominated, bonds. The table separately investigates the explanatory power for the broad dollar of flows by U.S. residents in corporates and sovereigns and dollar- and non-dollar-denominated bonds. Flows to corporate bonds denominated in US dollars has the most explanatory power for the US dollar, while flows to sovereigns in foreign currency are statistically significant, though weaker.[10]

These empirical findings suggest that when U.S. residents have a higher risk appetite, they pur-

[9] Models of portfolio balance such as Kouri (1976) and Gabaix and Maggiori (2015) connect foreign currency risk taking to exchange rates via imperfect substitutability of the assets. A growing empirical literature has focused on portfolio rebalancing of foreign currency exposures and its connection to exchange rates, including Hau and Rey (2006), Camanho et al. (2017), and Bergant and Schmitz (2018).

[10] In the Appendix Table A.10, we show bilateral exchange rates co-move with multilateral flows, rather than only flows to the related country, thus further corroborating our interpretation of flows as a proxy of global risk appetite.

chase foreign bonds and require a lower risk premium, leading safe-haven currencies to depreciate and risky currencies to appreciate. This logic suggests a similar relationship in domestic portfolio allocations, which unlike the BoP data, are included in our micro dataset. We explore this in Panel B of Table 1, which examine the co-movement between the broad dollar and changes in U.S. fund investment in overall domestic bonds, corporate bonds, and domestic sovereign bonds (Treasuries), the safest asset class. The first column of Panel B shows that overall flows into domestic bonds by U.S. residents covaries negatively with the broad dollar. This means that during times when U.S. mutual funds are increasing their flows into domestic debt, the broad dollar tends to appreciate. This is the opposite of what we saw for U.S. foreign bond flows. Interestingly, we find strong effects with opposite signs for domestic investment in corporate versus sovereign bonds. When U.S. funds purchase the riskier corporate bonds or sell the safer sovereign bonds, the dollar contemporaneously depreciates.[11]

Purchases of foreign bonds by U.S. mutual funds must be financed either by selling other securities or from net flows into the mutual fund sector. In appendix Table A.9 we show that it is flows into and out of the mutual fund sector, rather than purchases and sales of domestic securities by the funds themselves, that coincide with these foreign bond flows.

This duality between domestic risk-bearing capacity and foreign bond investments can be further confirmed by focusing on which type of funds drive the aggregate results. We sort U.S.-domiciled funds on four characteristics: total size of the fund, fraction of the fund that is invested in foreign assets, fraction of the fund that is invested in foreign currency, and how close a fund is to being a passive investor. We split funds into quintiles for each characteristic and report coefficient estimates and R^2 from univariate regressions of changes in the broad dollar on foreign bond flows for each of these subgroups in Figure 4.

The key driver of the aggregate results are the large active funds that are not specialized in foreign investment. Indeed, the upper left panels of Figures 4a and 4b show that the degree to which a fund specializes in foreign currency investments does not have a strong effect on the results. The upper right hand panels show that funds that have the least percentage of asset under management invested abroad have the strongest covariation and explanatory power for the exchange rate. The lower left panels show that it is the largest funds that drive the overall results. Finally, the bottom right panels show that the most passive funds have no explanatory power for the exchange rate. Therefore, we see that the aggregate explanatory power is driven by active funds who do not specialize in foreign investment. The fact that the results are driven by the purchases or sales of non-specialists supports the idea that the key driver of the aggregate results is the risk-bearing capacity of large U.S.-based investors, rather than the flows themselves causing exchange rate

[11]This pattern is consistent with investor retrenchment in bad times as shown empirically in Forbes and Warnock (2012) and modeled theoretically in Caballero and Simsek (2020).

changes.

4 Conclusion

This paper documents a correlation between global risk proxies, U.S. foreign bond purchases, and exchange rates that emerged starting with the global financial crisis. The US dollar, a safe-haven currency, depreciates when risk-appetite is high and when these flows out of the United States increase. And since currencies load heterogeneously on this global risk factor, these relationships explain more than just the broad US dollar, they also explain variation in bilateral currency pairs where one currency is considered "safe" and the other is considered "risky". The reconnect of the global risk proxies has clearly weakened relative to the 2007-2012 period, but appears to remain intact at the end of our sample. The reconnect of the U.S. capital flows, however, appears to have ended by 2018.

While we do not offer a theory of the reconnect nor do we establish a causal link between global risk proxies and U.S. foreign bond purchases, we offer here one possible view of the facts uncovered in this paper. Perhaps currencies began to strongly covary with measures of global risk at the time of the global crisis because of a drastic reduction in global financial intermediation capacity compared to global flows and a repricing of currency risk. This is consistent with the evidence in Du et al. (2017) that persistent CIP deviations have emerged after the crisis. Perhaps U.S. foreign bond purchases became connected with measures of global risk around the same time because that is the unique component of global capital flows whose direction alone reveals whether investors are shifting their portfolio towards riskier foreign securities compared to the ultimate safety of domestic government bonds. This is consistent with the idea that the US dollar's role as a safe asset and international currency has sharply increased since the financial crisis.[12] Seeing whether or not the reconnect continues or vanishes during a period of strong bank balance sheets and low uncertainty will help shed further light on the drivers of this episode.

[12] The literature on the international monetary system focuses on the dollar as a safe asset (Caballero et al. (2008); Gourinchas et al. (2011); Maggiori (2017); Farhi and Maggiori (2018)).

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Exhibits

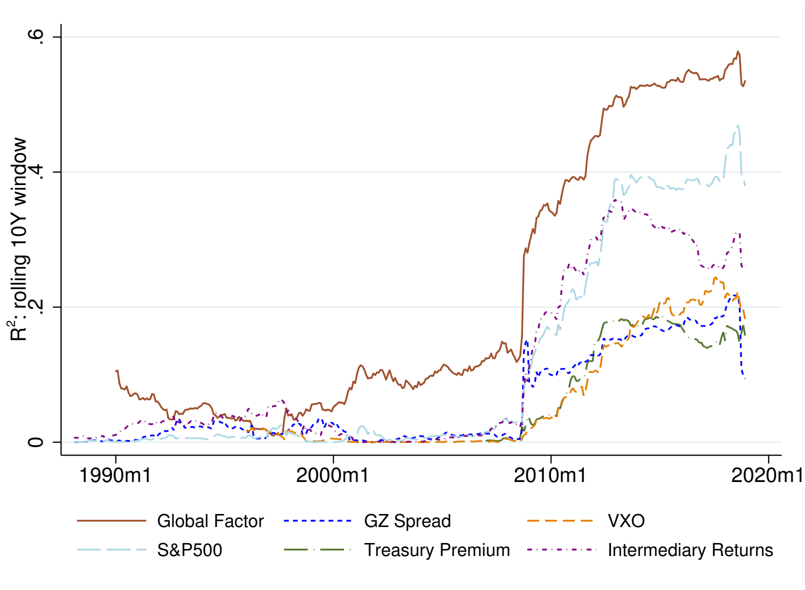
Table 1: US Dollar and Subcomponents of U.S. Outflows

		Panel A: Cross-Border Flows					*Panel B:* Within U.S. Flows			
		Δe^B_{USD}	Δe^B_{USD}	Δe^B_{USD}	Δe^B_{USD}	Δe^B_{USD}	Δe^B_{USD}	Δe^B_{USD}	Δe^B_{USD}	Δe^B_{USD}
Corporates	USD	0.43				0.36				
		(0.069)				(0.072)				
	NonUSD		0.085			-0.034				
			(0.065)			(0.068)				
Sovereigns	USD			0.15		-0.0024				
				(0.12)		(0.12)				
	NonUSD				0.24	0.16				
					(0.066)	(0.069)				
All U.S. Bonds							-0.51			
							(0.24)			
U.S. Sovereigns								-0.27		-0.18
								(0.082)		(0.088)
U.S. Corporates									0.76	0.51
									(0.25)	(0.28)
Observations		44	44	44	44	44	44	44	44	44
R2		0.35	0.03	0.04	0.22	0.42	0.10	0.20	0.21	0.27

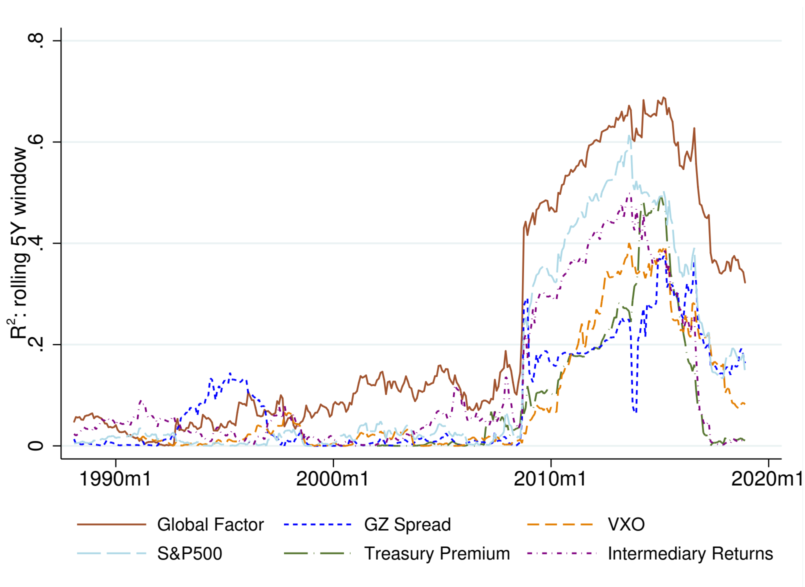
Notes: This table reports regressions results of the form $\Delta e^B_{USD} = \alpha + \beta f_t + \varepsilon_t$, where $\Delta e^B_{USD,t}$ is the quarterly change in the broad dollar and f_t is a particular measure of capital flows. All variables are defined as U.S. purchases of foreign securities belonging to a particular category, scaled by U.S. holdings of bonds belonging to that category at the end of the previous quarter. "Corporates" refers to corporate debt, "Sovereigns" refers to sovereign debt, "USD" indicates that the bond is denominated in US dollars, and "NonUSD" indicates that the bond is denominated in a currency other than the US dollar. Each row refers to a bond in the relevant category, a bond included in Corporates, USD indicates U.S. purchases of corporate debt issued by a non-US firm denominated in a currency other than the US dollar. "All United States Bonds" refers to U.S. domiciled mutual fund purchases of U.S. debt, scaled by the value all holdings of U.S. bonds by U.S. mutual funds at the end of the previous quarter. "U.S. Sovereigns" and "U.S. Corporates" are defined equivalently, restricting the sample to the universe of debt issued by the U.S. Federal Government and U.S. corporations, respectively. Exchange rate data are from Thomson Reuters Datastream and bond position data are from Morningstar. All other variables are defined equivalently. The sample period for all regressions is from 2007:Q1 to 2017:Q4. Standard errors are calculated allowing for heteroskedasticity. Exchange rate data are from Thomson Reuters Datastream and bond position data are from Morningstar.

Figure 1: Reconnect of The Broad Dollar and Risk Measures: R^2s

(a) 10-Year Rolling Window



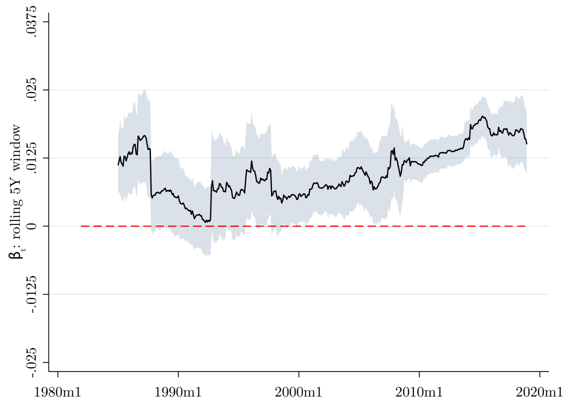
(b) 5-Year Rolling Window



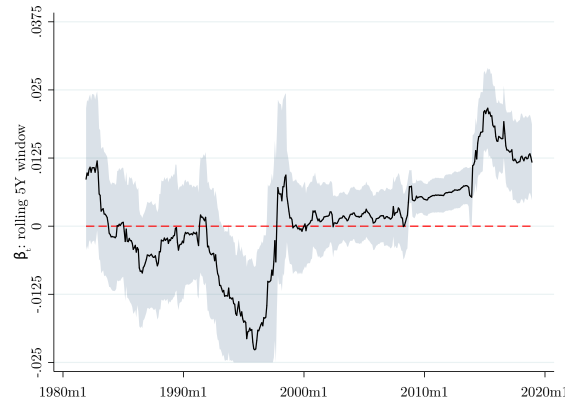
Notes: The figures show the 120- and 60- month rolling R^2 for regressions of the average log change in the US dollar versus the other G10 currencies against various indicators of risk. The regression specification is $\Delta e^{B}_{USD,t} = \alpha + \beta X_t + \varepsilon_t$, where X_t corresponds to different variables depending on the model in question. For "VXO," X_t is the monthly change in the log transformation of an index of implied volatility on the stocks in the S&P100, from the CBOE. For "S&P500," X_t is the log total return on the S&P500 index. For "Treasury Premium," X_t is the change in the one-year Treasury Premium, the average one-year tenor CIP deviation between developed country government bonds and U.S. Treasuries from Du et al. (2018). For "GZ Spread," X_t is the U.S. corporate bond credit spread, taken from Gilchrist and Zakrajšek (2012). For "Intermediaries," X_t is the value-weighted return on a portfolio of NY Fed primary dealers' holding companies and is taken from He et al. (2017). For "Global Return Factor," X_t is the global factor in world asset prices constructed by Miranda-Agrippino and Rey (2018).

Figure 2: Reconnect of The Broad Dollar and Risk Measures: βs

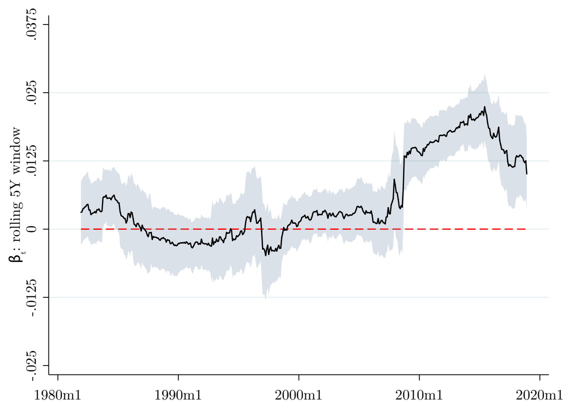
(a) Global Return Factor



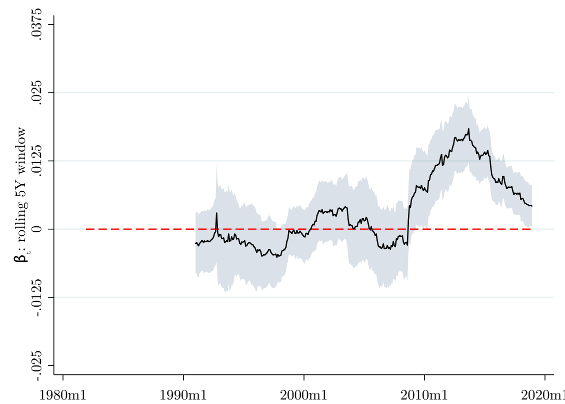
(b) GZ Spread



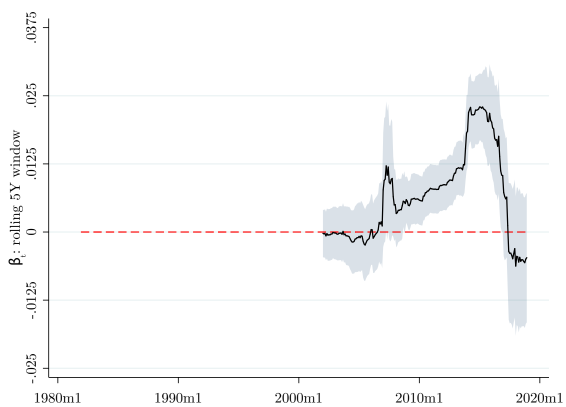
(c) S&P500 Log Return



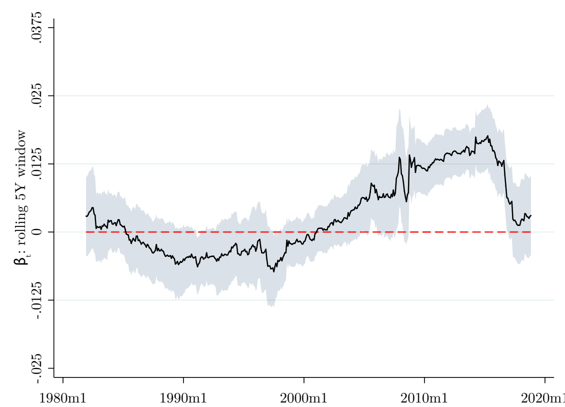
(d) Log VXO



(e) Treasury Premium



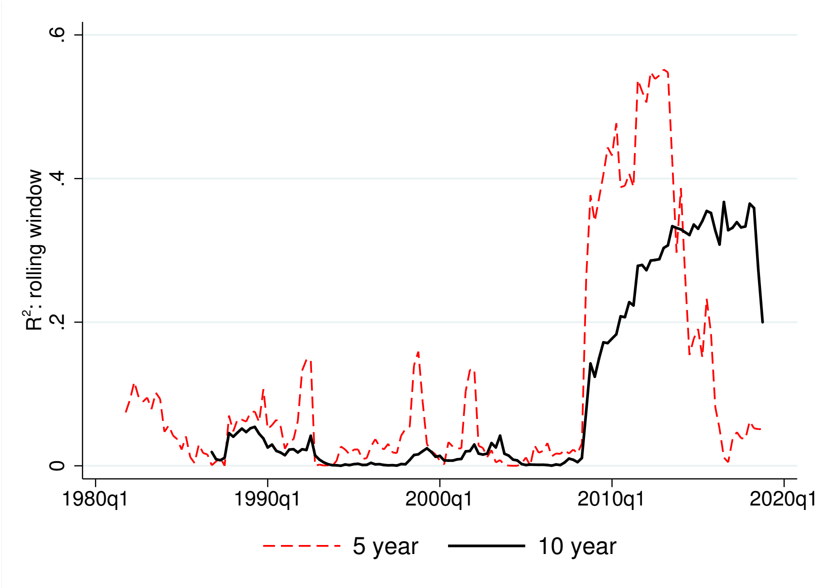
(f) Intermediary Returns



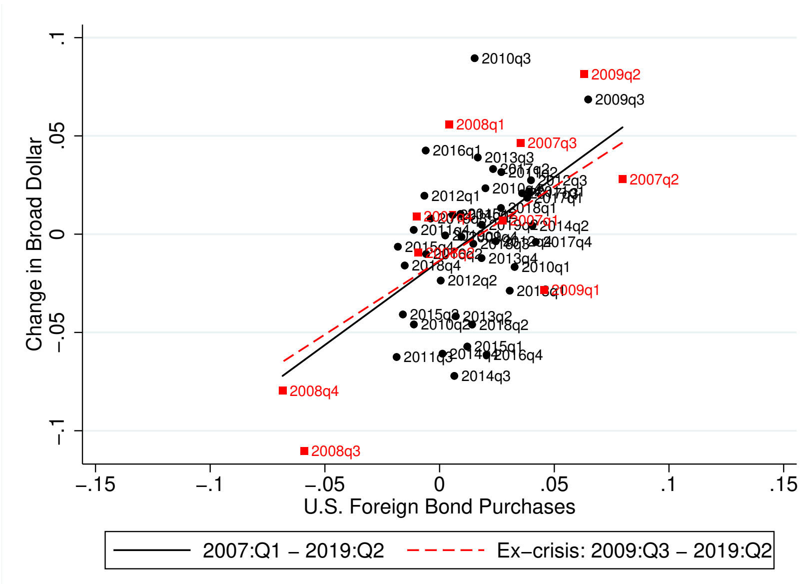
Notes: The figure shows the 60 month rolling β for regressions of the average log change in the US dollar versus the other G10 currencies against various indicators of risk, normalized as z-scores. The regression specification is $\Delta e^{B}_{USD,t} = \alpha + \beta X_t + \varepsilon_t$, where X_t corresponds to different variables depending on the model in question. For "VXO," X_t is the quarterly change in the log transformation of an index of implied volatility on the stocks in the S&P100, from the CBOE. For "S&P500," X_t is the log total return on the S&P500 index. For "GZ Spread," X_t is the U.S. corporate bond credit spread, taken from Gilchrist and Zakrajšek (2012). For "Global Factor," X_t is the global factor in world asset prices constructed by Miranda-Agrippino and Rey (2018). The shaded errors correspond to 95% confidence intervals, calculated using heteroskedasticity robust standard errors.

Figure 3: Reconnect of The Broad Dollar and U.S. Foreign Bond Purchases

(a) Rolling R^2s



(b) 2007:Q1-2019:Q2

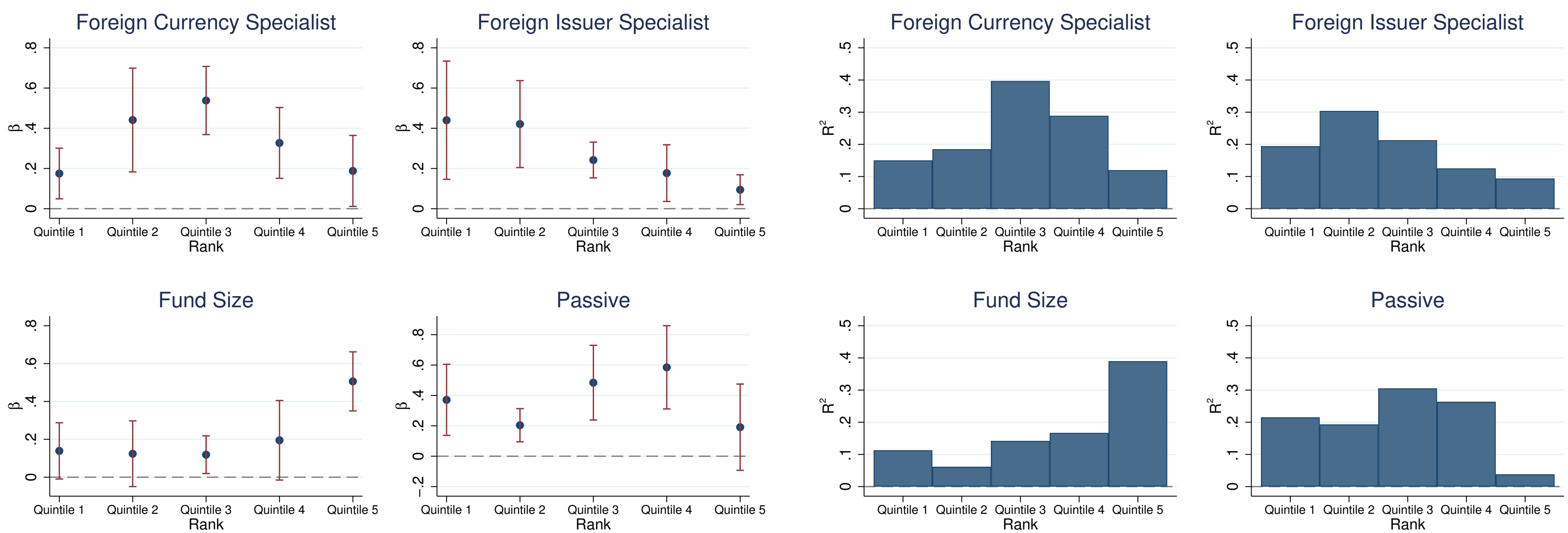


Notes: In the top panel, the y-axis corresponds to the R^2 of a 20- and 40-quarter rolling regression of the following specification: $\Delta e^B_{USD,t} = \alpha + \beta X_t + \varepsilon_t$, where $\Delta e^B_{USD,t}$ is the average log appreciation of the US dollar against all other G10 currencies and X_t is the U.S. net purchases of foreign bonds, normalized as a percentage of the U.S. value of foreign bond investment at the end of the prior quarter. In the bottom panel, the y-axis corresponds to the quarterly average change in the US dollar against all other G10 currencies, defined such that a positive value corresponds to a depreciation. The x-axis shows the purchases of foreign bonds by the United States in the contemporaneous quarter. Regression lines are estimated using the full sample (2007:Q1 to 2019:Q2) and excluding the crisis (2009:Q3 to 2019:Q2). In both panels, exchange rate data are from Thomson Reuters Datastream and bond purchase data are from the IMF Balance of Payments Database.

Figure 4: Broad US Dollar and U.S. Foreign Bond Purchases by Subsets of Mutual Funds

(a) Coefficients by Fund Characteristics

(b) R^2s by Fund Characteristics



Notes: This figure reports the coefficient estimate (Panel A), and R^2 (Panel B) of the following regression specification: $\Delta e^{\$}_{i,t} = \alpha_i + \beta_q f^q_t + \varepsilon_t$, where $\Delta e^{\$}_{i,t}$ is the change in average log change in the US dollar versus the other G10 currencies against f^q_t which is U.S. mutual funds' foreign bond purchases, normalized as a percentage of the same mutual funds' value of foreign bond investment at the end of the prior quarter, subsetted into fund quantiles q. In each panel, we separately construct the flow measure for some quintile of the mutual fund universe. We first explain this process for fund size (the AUM in US dollar). For each quarter from 2007:Q1 to 2019:Q2, we sort each fund i by AUM separately within 10 fund categories (e.g. Fixed Income, Equity, Money Market) as defined by Morningstar and measure their percentile ranking within each category for that quarter, $R_{i,t}$. We then average that percentile ranking for each fund over all t, to yield an average ranking $\bar{R}_i$. We then sort each category by $\bar{R}_i$ into 5 quintiles of an equal number of funds. Then we aggregate the positions of each quintile and construct the flow in the usual way. The characteristic "foreign currency specialist" is defined by the percentage of bonds the fund holds in currencies other than the US dollar. The characteristic "foreign issuer specialist" is defined by the percentage of bonds the fund holds which were issued by a foreign parent, using the parent match procedure described in (Coppola et al., 2019). The characteristic "passive" is defined by the R^2 of the fund's monthly returns with the monthly returns of any bond or equity index (we compare their returns with the returns of the 500 most popular indices and take the maximum). Quintile 5 corresponds to largest AUM, highest proportion of foreign currency bonds (by AUM), highest proportion of foreign country issuers (by AUM), highest R^2 with a published index for fund size, foreign issuer specialist, foreign currency specialist, and passive respectively.