Monetary Policy Transmission through the Exchange Rate Factor Structure

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Abstract

We show that US monetary policy is transmitted internationally through the factor structure of exchange rates. Following an unexpected easing, investment funds sell safe and buy risky currencies. Global US banks, similarly, tilt their distribution of foreign loan origination toward currencies of greater systematic currency risk. The effects of monetary policy on currency flows and loans persist for several months and feed into the leverage and real investment decisions of firms and, in particular, those that operate using a high-risk currency. We argue that currencies' factor exposures are a lens through which we can understand the international transmission of US monetary policy.

J.E.L. classification: F31, G12, G15

Keywords: currency flows, exchange rate factor structure, monetary policy, US dollar

I. Introduction

A prominent view in international finance interprets exchange rate movement via a factor structure (Lustig, Roussanov, and Verdelhan, 2011). This modern idea, which posits that a currency's variation is principally driven by its exposures (betas) to systematic risk factors, has been quite successful at explaining the risk and return of investing in foreign exchange (FX). Currencies with low or negative betas are considered safe investments and earn small returns, whereas those with high betas are risky and their holders are compensated with large returns. But can these exposures enlighten economists beyond an exchange rate's expected return and risk? Do currency betas connect more broadly to other macroeconomic phenomena?

In this paper, we show that US monetary policy is transmitted internationally through the exchange rate factor structure. To fix ideas, consider an unexpected easing in the policy rate of the Federal Open Market Committee (FOMC). Post-easing, we find that investment funds (mutual, pension, and hedge funds) pursue a "risk-on" strategy by rebalancing up the risk spectrum of exchange rates; that is, funds sell safe currencies like the Japanese yen to buy risky ones like the Australian dollar. Global US banks, similarly, reallocate their international loan origination from low- to high-risk currencies. These responses, in turn, produce lasting, real economic effects: foreign firms that principally operate using a risky currency borrow, lever up, and invest in physical assets more relative to firms that operate using safe currencies.

Our mechanism relates to the risk-taking channel of monetary policy (Borio and Zhu, 2012), which postulates that monetary policy impacts the willingness of market participants to take on risk exposures and thereby influences financial conditions and, ultimately, real economic outcomes (Bruno and Shin, 2015).[1] Our novel contribution is to show that currency exposures provide a lens through which economists can understand how US monetary policy is transmitted to other economies.

We begin by analyzing the response of currency flows to US monetary policy announcements. One challenge we face in our analysis is that currency flows and monetary policy are jointly determined. To overcome this, we use the high-frequency changes in Federal Funds futures prices surrounding FOMC announcements for identification (Kuttner, 2001; Bernanke and Kuttner, 2005). Another complication is that measuring flows of currencies is difficult, which is a consequence of the market being complex in traded instruments, decentralized across players, and global in nature. Key to our analysis is thus, the use of settlement data provided by Continuous Linked Settlement (CLS) Group, which covers around half of currency trading volume for various players transacting in

[1] In Appendix A we illustrate theoretically that an unexpected decline in the Federal Funds rate either lowers the risk aversion or expands the risk-taking capacity of funds and banks, generating the risk-on patterns that we document in this paper.

spot and derivative markets alike. We discuss these data along with our other auxiliary sources in Section II.

In Section III we show that monetary shocks produce a strong and directional impact on currency flows, especially for investment funds and banks. For context, a typical 10 basis point (bp) expansionary monetary surprise induces fund flows into the Australian dollar of around $1,904mn. This is more than two-thirds of the standard deviation of monthly USDAUD flows. We interpret these coefficients as *flow betas* because, as we show, they align well with currency betas.

We then assess how measures of currency risk impact these flows. We focus on two measures: carry and dollar betas. Verdelhan (2018) documents that these two factors account for a substantial fraction of bilateral exchange rate variation. These betas summarize the set of a country's characteristics that collectively determine its currency's risk. Among other things, currencies with large carry betas tend to possess high interest rates (Lustig and Verdelhan, 2007), whereas currencies with large dollar betas typically face greater impediments to trade in goods (Lustig and Richmond, 2019).

In our regressions, the key regressor is an interaction of currency risk with the monetary policy shock. We thus treat exchange rate risk as an instrument through which we shock outcomes. We find that both carry and dollar exposures influence the direction and magnitude of investment funds' flows: funds reallocate positions from low- to high-risk currencies following a monetary easing in the US, and vice versa. And while the US monetary shock is transient, its effect is long-lived. We show that currencies with low carry betas tend to experience outflows over the following five months, whereas currencies with high carry betas face a lasting wave of demand, persisting beyond that period.

In addition to investment funds, banks also play an outsized role in currency markets, primarily as market makers. The anonymized nature of the CLS data, unfortunately, precludes us from analyzing within-bank or bank-to-bank transactions. We study therefore in Section IV how US monetary policy affects global US banks' international loan origination. In line with Bräuning and Ivashina (2020a), we confirm that a reduction in the Federal Funds rate leads to less lending in foreign currencies by banks that are domiciled in the United States. However, we also document that the magnitude of this decrease is affected by the denomination of the loan's currency. Loans in safe currencies witness the largest decline, whereas loans in riskier currencies experience a smaller reduction or even loan growth. Thus, banks tilt the distribution of their lending portfolios toward riskier currencies following a monetary easing.

Finally, in Section V we turn to study how firms are impacted by the currency in which they primarily operate and borrow. To do so, we link our database on global US banks' lending to international firms' financial statements, allowing us to tie loan origination to real outcomes. In our regressions, we control for country-time fixed effects that absorb variation due to demand effects in foreign countries, isolating the effect of loan supply. In fact, our data allow us to distinguish a firm's operating currency from its country's currency, and hence, our estimates are identified based on the variation that comes from firms borrowing in different currencies within the same country.

Eventually, we show that foreign firms that primarily operate using risky currencies are impacted differently by changes in US monetary policy than firms that use safe currencies. Specifically, firms that use high-risk currencies experience, a positive loan supply shock from global US banks following the unexpected easing in the Federal Funds rate. These firms, in turn, use the loans to expand their balance sheets, increase leverage, and invest more in tangible assets.

In sum, our evidence indicates that expansionary US monetary policy causes both funds and banks to tilt their portfolios towards riskier currencies. Perhaps this is not surprising. But we further show that these effects feed through to foreign firms' real decisions. Despite the transient nature of the monetary policy shock, the real economic effect persists, and the magnitude of this spillover effect to a foreign economy is determined by the currency's location in the factor structure of exchange rates.

Related Literature

Since Fama (1984), an extensive literature in international finance has studied the economic reasons for uncovered interest rate parity (UIP) deviations. One enduring view is organized around systematic currency risk. Indeed, several papers have found support of this risk-based view of exchange rates, which posits that currencies' average excess returns should align with their systematic risk exposures. For instance, Verdelhan (2018) shows that dollar and carry betas are central in explaining bilateral exchange rate movements, whereas in recent work Liu, Maurer, Vedolin, and Zhang (2022) and Nucera, Sarno, and Zinna (2023) argue that the same two factors also explain a large cross-section of currency portfolio returns. These exposures, in turn, have been shown to be related to the fundamental characteristics of countries.[2] In contrast to much of the focus of this literature, we study whether the exchange rate factor structure has economic implications beyond a currency's expected return and risk.

Another vein of work in international macroeconomics studies how monetary policy shocks propagate across the global economy. The vector autoregression literature, for

[2]For example, a country's characteristic like its interest rate (Lustig et al., 2011), exposure to global volatility (Menkhoff, Sarno, Schmeling, and Schrimpf, 2012a), size (Hassan, 2013), external imbalances (Della Corte, Riddiough, and Sarno, 2016), trade composition (Ready, Roussanov, and Ward, 2017), global growth news exposure (Colacito, Croce, Gavazzoni, and Ready, 2018), trade centrality (Richmond, 2019), geography of trade (Lustig and Richmond (2019) and Hassan, Loualiche, Pecora, and Ward (2023)), sovereign credit risk (Della Corte, Sarno, Schmeling, and Wagner, 2022), and liquidity risk (Söderlind and Somogyi, 2024) have all been shown to impact its currency's risk.

example, studies impulse responses of international macroeconomic variables to structural shocks (Eichenbaum and Evans, 1995; Stavrakeva and Tang, 2015; Schmitt-Grohé and Uribe, 2018). Instead, our work uses more recent techniques to achieve a cleaner identification by using high-frequency movements in futures prices surrounding monetary policy shocks (Kuttner, 2001; Bernanke and Kuttner, 2005). In robustness, we also consider some of the most recent advances in measuring monetary policy surprises (e.g., Nakamura and Steinsson, 2018; Jarociński and Karadi, 2020; Kearns, Schrimpf, and Xia, 2022; Bauer and Swanson, 2023a,b).

Recent papers examine the dynamics of various assets that are driven by FOMC announcements. A selected sample of papers that study equity, option, and bond returns around FOMC meetings are Savor and Wilson (2014), Lucca and Moench (2015), Ai and Bansal (2018), Cieslak, Morse, and Vissing-Jorgensen (2019), and Roussanov and Wang (2023). Notably, Mueller, Tahbaz-Salehi, and Vedolin (2017) study US dollar movements surrounding monetary policy announcements. They show that a simple trading strategy that shorts the dollar and buys foreign currencies earns high excess returns during days with announcements. Contemporaneously, Antolin-Diaz, Cenedese, Han, and Sarno (2023) document that currencies that are more exposed to US monetary policy yield positive average returns. They show that currency characteristics explain the cross-sectional heterogeneity of these exposures across currencies and time.

We depart from this literature in three ways. First, we study the response of investment funds' currency flows (rather than currency returns) and global banks' loan origination to monetary policy shocks. Second, we relate the magnitudes of these flows and loans to measures of systematic currency risk that go beyond just interest rate differentials. Finally, we tie the change in the distribution of loan origination to firms' real decisions, and in particular their leverage and investment choices.

Our study aims to connect the exchange rate factor structure to the real international transmission of US monetary policy.[3] Ottonello and Winberry (2020) assess the investment channel of monetary policy among US non-financial firms, though they do not study the channel in other countries. Zhang (2021) explores the role of trade invoicing currencies in the international spillover of monetary policy and shows that exchange rates, interest rates, and equity returns in countries with larger dollar-invoicing share respond more to US monetary policy. We provide complementary insights to this line of reasoning by focusing on quantity flows induced by monetary policy and their real effects as well as by linking the differences across currencies to measures of systematic currency risk. Bräuning and Ivashina (2020a) examine how changes in central banks' interest rates affect global banks' allocations of lending across domestic and foreign markets. Correa,

[3]Related is also the literature on international transmission of bank liquidity: for example, Schnabl (2012), Cetorelli and Goldberg (2012), and Temesvary, Ongena, and Owen (2018).

Paligorova, Sapriza, and Zlate (2021) analyze the impact of monetary policy on bilateral cross-border bank flows using the Bank of International Settlements (BIS) locational banking statistics database. Their focus is on policy rate changes abroad rather than in the US and they provide no link to measures of systematic currency risk. We contribute to this branch of literature by studying the response of not only banks but also funds to monetary shocks, and we link these responses to the factor structure of exchange rates.

More broadly, our work connects to the global financial cycle (Rey, 2013; Miranda-Agrippino and Rey, 2020) and the risk-taking channel of monetary policy (e.g., Borio and Zhu, 2012; Bruno and Shin, 2015, 2017; Adrian, Estrella, and Shin, 2019; Bauer, Bernanke, and Milstein, 2023). Parts of this literature focus on the implications for emerging market credit cycles and financial crises such as Gourinchas and Obstfeld (2012) and Bräuning and Ivashina (2020b). Different from these papers, we show evidence that the currency factor structure can provide a simple framework to better understand monetary policy transmission.

II. Data and Summary Statistics

Our four primary databases span exchange rates, currency flows, global loan origination, and corporate balance sheets. While some data are available at high frequency, we primarily analyze monthly, quarterly, and lower frequencies as we focus on the impact of monetary policy on real economic outcomes. Our sample period ends in March 2024 and is restricted by the loan data, which begins in 2000, and the flow data, which begins later in 2012. We discuss these sources in turn.

A. Exchange Rates, Forward Contracts, and Excess Returns

We collect hourly data on spot mid, bid, and ask quotes and daily forward prices for various maturities from Bloomberg. We denote the spot price for country i at time t by $S_{i,t}$ and forward prices by $F_{i,t}$. An increase in F or S corresponds to an appreciation of the US dollar relative to the foreign currency. We use mid prices when calculating exchange rate changes, $\Delta \log S_{i,t}$, and compute relative bid-ask spreads to measure liquidity in the form transaction costs.

During normal market periods, forward rates must satisfy the covered interest rate parity condition. Under this condition, interest rate differentials approximate the forward discount, the difference of the log forward price from the log spot price. We use forward and spot prices to compute interest rate differentials: $r_{i,t} - r_{US,t} \approx \log F_{i,t} - \log S_{i,t}$. The term of the interest rate depends on the maturity of the forward and, following the literature, we use one-month contracts unless otherwise noted.

B. Measures of Systematic Currency Risk

We focus on dollar and carry betas. Betas quantify an asset's exposure to systematic risk factors. Verdelhan (2018) shows that the dollar and carry factors jointly account for the majority of variation in bilateral exchange rates relative to the dollar, explaining between 19 and 91 percent of the exchange rate variation among developed countries.

Dollar and carry factors mimic, respectively, the first and second principal components (PC) of carry trade returns (which include interest rate differentials). But factors improve upon principal components because they possess an economic interpretation and a currency's factor exposure is more stable over time compared its PC loading.

The dollar factor is the average change in all currencies with respect to the US dollar. It is akin to the capital asset pricing model's market portfolio. The carry factor mimics the returns of the well-known carry trade strategy, which is the long-short portfolio return of a zero-cost trading strategy that borrows in low interest rate currencies to invest in high interest rate currencies. We create this portfolio by sorting, every month, currencies into five portfolios based on the one-month forward discount relative to the US dollar prevailing over the previous month. The "long" portfolio consists of currencies with the highest interest rates relative to the US, whereas low interest rate currencies constitute the "short" portfolio.

We consider the same cross-section of 39 countries as in Verdelhan (2018) but exclude Euro area countries as our sample period starts in January 2000. This leaves us with 28 countries to construct the risk factors.

We estimate dollar β_i^{DOL} and carry β_i^{CAR} betas using a 60-month rolling window regression of log changes in currency i's exchange rate $S_{i,t}$ on either the dollar or the carry factor:

$$\Delta \log S_{i,t} = a_i + \beta_i^{DOL} Dollar_t + \epsilon_{i,t}, \tag{1}$$

$$\Delta \log S_{i,t} = a_i + \beta_i^{CAR} Carry_t + \epsilon_{i,t}. \tag{2}$$

We estimate these betas separately but include both of them simultaneously in the cross-sectional analysis in the next section.

Dollar and carry betas summarize the assortment of a country's characteristics that collectively determine its currency's risk. For example, countries with large carry betas tend to be on the periphery of the global trade network (Richmond, 2019) and typically export commodities and import finished goods (Ready et al., 2017). Carry betas generally line up with interest rate differentials (Lustig et al., 2011). Countries with large dollar betas typically face large trade costs in goods, which relates to the gravity equation in international trade (Lustig and Richmond, 2019; Hassan et al., 2023). These economic sources of currency risk are not mutually exclusive. Thus, the carry and dollar betas are useful as they proxy for deeper economic phenomena but are defined by their ability to capture a currency's systematic risk exposure. In Section VI we investigate these deeper sources of country-level risk.

Analogous to a stock market beta, dollar betas record the incremental systematic risk that a US investor takes on when investing in foreign currency i, whereas carry betas measure currency i's exposure to the carry factor. Higher values of dollar and carry betas indicate greater exposure to systematic currency risk.

C. Monetary Policy Shocks

The use of high-frequency identification to study the effect of monetary policy transmission has become standard in macroeconomics and asset pricing. Currency markets (Andersen, Bollerslev, Diebold, and Vega, 2003), bank lending (Bräuning and Ivashina, 2020a), and firm-level investment (Ottonello and Winberry, 2020) are all known to react strongly to changes in central bank policy rates. We follow Kuttner (2001) to measure the surprise component in the monetary policy target rate around an FOMC announcement on day t as follows:

$$MPS_t = (ff_t^0 - ff_{t-1}^0)\frac{m}{m-t}, \tag{3}$$

where m is the number of days in a given month and ff_t^0 is the Fed Fund futures price for a contract that expires at the end of the current month. The date at which the target rate is changed is denoted by t, typically the second day of the FOMC meeting. On the last three days of a month (when $m - t$ gets small), we use $ff_t^1 - ff_{t-1}^1$ instead for stability, where ff_t^1 is the Fed Fund futures price for a contract that expires at the end of the next month. Hence, an increase in MPS_t corresponds to a reduction in rates, an easing of monetary policy, and a positive or an expansionary monetary policy shock.

To aggregate high-frequency shocks to the monthly or quarterly frequency we simply sum all shocks in a given time period. As an alternative, we follow Ottonello and Winberry (2020) to aggregate the high-frequency shocks to the monthly frequency. Specifically, we construct a moving average of the high-frequency shocks weighted by the number of days in the month after the shock occurs. This type of aggregation ensures that we weight shocks by the amount of time market participants have had to react to them. Our findings are robust to using this alternative form of time aggregation.

Table 1 indicates that these time aggregated shocks have similar features to the original high-frequency shocks. The average monthly and quarterly standard deviation across measures is around 10 basis points. The median realization for all shocks is zero.

We analyze other measures of monetary policy shocks in Section VI. In particular, our main results are robust to using the latest high-frequency shocks in Bauer and Swanson (2023b), which account for the FOMC adjusting to new macroeconomic information

Table 1. Summary Statistics of Monetary Policy Shocks

		Monthly		Quarterly	
	High-frequency	Simple sum	Weighted sum	Simple sum	Weighted sum
Mean	1.23	1.25	0.85	2.53	1.31
Median	0.00	0.00	0.00	0.00	0.00
Std.	8.42	9.17	7.90	11.95	9.03
Min.	−24.89	−24.89	−24.89	−29.19	−23.50
Max.	74.06	83.24	72.43	66.55	51.47
#Obs	200	196	196	97	97

Note: This table reports summary statistics of monetary policy shocks following Kuttner (2001). All numbers are in basis points (bps), except for the row labelled "#Obs", which shows the number of monetary policy shocks over the sample period from 1 January 2000 to 31 March 2024. The first column labelled "High-frequency" refers to shocks that are estimated using the event study strategy in Eq. (3). The columns labelled "Simple sum" aggregates the high-frequency shocks by simply summing up all shocks within a month or quarter, whereas the columns labelled "Weighted sum" aggregates the shocks to a monthly or quarterly frequency using the weighted average method described in the main text.

just prior to the FOMC announcement. For completeness, we document in the Online Appendix that our findings are driven neither by unscheduled monetary policy announcements nor the Covid-19 market turmoil in March 2020.

Given that our main analysis is at the monthly and quarterly frequencies, a concern is that market participants are responding to other central banks' decisions, preceding the FOMC announcement. We address this concern in two ways: First, we directly control for the monetary policy announcement surprise of foreign central banks.[4] Second, in Table 11 we provide evidence that foreign central banks' policy actions tend to be positively correlated with the Fed. Hence, controlling for foreign monetary policy announcement surprises is only a valid approach as long as foreign central banks' decisions are independent from the Fed.

D. Currency Flow Data

Our currency flow data come from CLS Group, which operates the world's largest multi-currency cash settlement system and handles nearly 50 percent of global FX volumes. These data are well-suited to our analysis as we observe currency volume and order flow on a global scale for a range of currency instruments and players.[5] Currencies are traded

[4] We are grateful to Nihar Shah for sharing his monetary policy shock series for G10 central banks with us. Note that the foreign central banks shock series ends in December 2016 and hence, we only utilize this data for the longer sample period pertaining to foreign currency lending by US banks.

[5] Collectively, the papers by Hasbrouck and Levich (2017), Cespa, Gargano, Riddiough, and Sarno (2021), Ranaldo and Somogyi (2021), Hasbrouck and Levich (2021), Khetan and Sinagl (2022), and Kloks, Mattille, and Ranaldo (2023) have comprehensively described the CLS data. Although CLS

in spot, forward, and swap markets. The latter two instruments are broken down into various maturity buckets.

Our CLS data sample of currency flows covers the period from September 2012 to March 2024. We consider the G10 currencies of developed markets against the US dollar (USD): Australia (AUD), Canada (CAD), Euro area (EUR), Japan (JPY), New Zealand (NZD), Norway (NOK), Sweden (SEK), Switzerland (CHF), and United Kingdom (GBP).[6] In the Online Appendix we demonstrate that our results are robust to including the less heavily traded emerging market currencies of Israel (ILS), Mexico (MXP), and South Africa (ZAR).

To protect anonymity, CLS reports only hourly aggregates of trading volume and order flow by currency and customer (institution) type. There are two broad classifications of market participants: dealer banks and institutions. Dealer banks are market makers that quote prices,[7] whereas price-taking institutions can be divided into four types:

- Corporates: non-financial corporations.
- Funds: mutual funds, pension funds, and high-frequency trading firms.
- Non-bank financials: insurance companies and endowments.
- Non-dealer banks: banks that are not market makers in a specific currency.

We compute directional currency flows as the net buying pressure of a foreign currency in US dollars. We first convert all volumes in the CLS data to dollars using our spot exchange rates. For each hour, we then compute the difference between purchases and sales for each foreign currency i and institution type j,

$$OF(Y_{ij,t}) = \text{Buy Volume}_{ij,t} \text{ in \$} - \text{Sell Volume}_{ij,t} \text{ in \$}, \tag{4}$$

where Y denotes the asset in question (e.g., either spot or forward).

A positive realization of order flow, $OF(Y)$, implies that the demand for a given foreign currency was larger than the demand for US dollars. Figure 1 shows a sample of spot EURUSD transactions executed within 12 to 1pm (hour 12) GMT on 2 January

operates five-and-a-half days a week from 10pm CET Sunday to 2am Saturday, the vast majority of settlement instructions are received during the so-called London trading hours from 8am to 5pm GMT. The results that we report below are based on this subsample but are similar to those based on the 24-hour trading day.

[6] We restrict our sample by excluding currencies that are pegged (i.e., Denmark (DKK), Hong Kong (HKD), and Singapore (SGD)). We also exclude Hungary (HUF), entering the data set on 7 November 2015, and South Korea (KRW), due to insufficient amount of trades per institution type.

[7] Dealer banks are classified via network analysis done by CLS Group. By observing the frequency of trades over time across banks, CLS can create a set of banks that are connected to the majority of other banks in the *same* set. Dealer banks are those that remain in this set consistently over time. The network analysis is done independently for each currency pair using 24 months of data. Within this classification, one bank could be a market maker in one currency yet a price taker in another. Note that CLS data only report transactions between dealer banks and their customers and exclude trades between two dealer banks or two non-dealer banks.

2019. The flow attributed to funds in the last column is the largest in magnitude for this data point. Specifically, the order flow to exchange euros for dollars by funds alone was \$669mn in that single hour.

Figure 1. Snapshot of CLS Data

FX Spot Flow - Hourly - Daily

EURUSD = 1.13126 on 2 January 2019

currency	instrument	london_date	hour	price_taker	market_maker	buy_ccy	sell_ccy	buy_volume	sell_volume	buy_volume_USD	sell_volume_USD	order_flow
EURUSD	SPT	2019-01-02	12	BuySide	SellSide	EUR	USD	1,597,927,686	2,245,621,149	1,807,671,675	2,540,381,381	-732,709,707
EURUSD	SPT	2019-01-02	12	Corporate	Dealer Bank	EUR	USD	88,656,999	9,786,333	100,294,116	11,070,887	89,223,229
EURUSD	SPT	2019-01-02	12	Fund	Dealer Bank	EUR	USD	42,908,060	634,132,478	48,540,172	717,368,707	-668,828,535
EURUSD	SPT	2019-01-02	12	Non-Bank Financial	Dealer Bank	EUR	USD	51,267,386	132,102,521	57,996,743	149,442,298	-91,445,554
EURUSD	SPT	2019-01-02	12	Non-Dealer Bank	Dealer Bank	EUR	USD	**1,415,095,242**	**1,469,599,817**	**1,600,840,643**	**1,662,499,490**	**-61,658,846**

Note: The values in bold denote the "residual" calculated to define non-dealer banks. For buy volume, it is calculated by subtracting the volume from corporates, funds, and non-bank financials from total buy-side (price taker) activity; there is a similar calculation for sell volume.

Next, we aggregate hourly currency flows to the monthly frequency. We time-aggregate for two reasons. First, currency flows, like stock returns, are quite noisy. By cumulating them to a longer horizon we are better able to filter a directional signal from the noise present in hourly data. Second, we are interested in the long-lasting impact of monetary policy on FX flows rather than the high-frequency intraday response. Note that all our key results (for both currency flows and syndicated loans) are qualitatively similar when aggregating to the weekly rather than monthly frequency.

Table 2 presents summary statistics for spot currency flows broken down by institution and currency pairs. We report standard deviations and the share of each currency pair's trading volume that is accounted for by each institution. Each pair's average flow is close to zero and not reported. Funds and non-dealer banks generate, by far, the most directional flows as measured by their standard deviations. Across all currency pairs, trading activity by funds and non-dealer banks easily exceeds the combination of corporate or non-bank financial accounts. We also see that funds and, especially, non-dealer banks dominate currency markets as they collectively account for more than 95 percent of the total trading volume across all currency pairs.

The large economic impact of funds is consistent with the findings from the FX market microstructure literature.[8] In contrast, both non-dealer banks and dealer banks are more likely to be providers of liquidity.

[8] In particular, Menkhoff, Sarno, Schmeling, and Schrimpf (2016) and more recently Czech, Della Corte, Huang, and Wang (2022) show that the currency flows of funds and real money investors constitute "smart money" that is highly predictive of future exchange rates. These funds trade strategically and have substantial contemporaneous and permanent price impacts across currency pairs (Ranaldo and Somogyi, 2021).

Table 2. Summary Statistics — CLS

	Corporates		**Funds**		**NBFIs**		**Non-dealer banks**	
	Std.	Share	Std.	Share	Std.	Share	Std.	Share
USDAUD	0.42	0.36	2.65	10.98	0.46	3.18	3.97	85.49
USDCAD	0.70	0.29	15.58	10.40	1.03	1.98	31.40	87.33
USDCHF	0.57	0.90	2.41	9.06	1.45	4.17	4.27	85.87
USDEUR	3.46	2.19	11.39	13.78	1.45	3.18	14.67	80.85
USDGBP	1.23	1.00	5.82	13.02	1.56	3.56	7.96	82.42
USDJPY	0.94	0.85	4.81	8.93	0.96	3.14	6.19	87.08
USDNOK	0.12	0.45	0.58	12.75	0.10	2.94	1.55	83.86
USDNZD	0.04	0.08	1.18	7.30	0.15	3.46	1.68	89.16
USDSEK	0.18	1.18	0.97	20.78	0.12	2.78	1.64	75.26

Note: This table collects simple summary statistics for the CLS order flow data. The columns labelled *Std.* report the standard deviation of monthly order flows (buy volume minus sell volume) in $bn broken down by four categories of market participants, namely, corporates, funds, non-bank financials (NBFIs), and non-dealer banks. The columns labelled *Share* are computed based on the sum of buy and sell volume and reflect the relative share (summing up to 100% for each currency pair) in percent of trading volume associated with each of the four groups of market participants. The sample covers the period from September 2012 to March 2024.

E. Global Banks' Loan Origination

We use the Thomson Reuters DealScan database for global corporate loan issuances. It primarily covers syndicated loans, which are typically larger than non-syndicated loans. Bräuning and Ivashina (2020a) report that syndicated loans represented at least 45 percent of all US commercial and industrial lending in 2016. The database has information on borrowers, their home country, the syndicate's lenders, and loan details such as the amount (broken down by each lender) and currency.

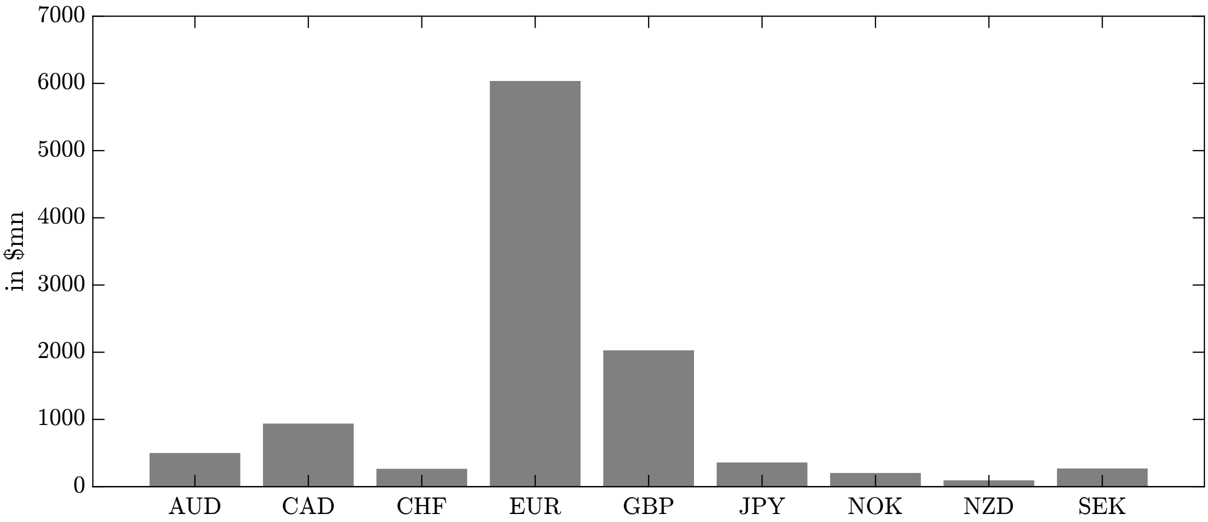
In our analysis, we focus on top-tier lenders within a syndicate by excluding lenders with smaller commitments (so-called "Participants"). We also drop observations with negative tranche amounts or if the tranche amount exceeds the deal amount. We consolidate a bank's loan activity across its parent and subsidiaries.

Given that we study the transmission of US monetary policy we filter for syndicated loans that involve at least one US bank. We define *global US banks* as those that are domiciled in the US and are internationally active in the sense that they provide foreign currency loans. For each global US bank in every month, we aggregate all loans denominated in the same foreign currency by leveraging information about the share that the bank has lent across every syndicate. Specifically, we follow Bräuning and Ivashina

(2020a) and prorate the loan amount among lenders in our sample because information on the share held by individual banks is scarce in the DealScan database.

Figure 2 shows that US banks' foreign lending is concentrated in a handful of currencies. For instance, US banks lend on average \$6,036mn in EUR and \$2,028mn in GBP each month. Our final data sample spans from January 2000 to March 2024 and contains the same G10 currencies as for the CLS currency flows.

Figure 2. Snapshot of DealScan Data



Note: This figure reports the average of the total aggregate loan amount in a given currency aggregated over a month. The sample covers the period from January 2000 to March 2024.

F. Corporate Borrowers and their Balance Sheets

Our data on international corporations comes from their quarterly financial statements via Compustat North America and Compustat Global. These data cover over eighty-thousand firms of which only twelve-thousand have ever borrowed via a syndicated loan.

We apply standard filters and exclude firms that are in finance, insurance, or real estate (SIC codes 6000 to 6799) and public administration (9100 to 9729) and remove observations of negative assets, property, plant, and equipment (PPE), and sales. We retain only non-US firms that report using a G10 currency and convert all balance sheet variables to US dollars.

For firms that do borrow from a syndicate, we aggregate all loans issued in the same currency within a quarter. If a firm borrows in more than one currency in any given quarter, we only keep the loans that are issued in the firm's reporting (i.e., operating) currency. After this filtering, we are left with 1,305 international firms.[9]

[9]Note that the number of firms that we use in some regressions is less than 1,305 because we take first differences in firm-level outcome variables and thus, lose firms that are not reporting every quarter.

Table 3 presents summary statistics of the final sample. Total firm-quarter observations amount to over 55,000. The average firm has a current asset ratio of 0.36 and is around 30 percent debt financed. Firm debt, assets, PPE, and sales grow on average by around two percent nominally every quarter. The average loan amount that firms receive from US banks is around \$1,169mn with a sizable standard deviation of \$2,664mn per quarter. The average firm borrows from US banks around three times, translating to around \$3,507mn in lending over our sample from January 2000 to March 2024.

Table 3. Summary Statistics — Compustat

	#Obs	Mean	Std.	5%	25%	50%	75%	95%
current asset ratio in %	73,679	36.4	20.3	6.4	20.6	34.8	50.5	71.8
book leverage in %	67,116	30.2	26.7	4.1	18.3	28.0	39.1	60.0
Δ log debt in %	56,803	2.4	103.9	−24.4	−4.5	0.0	4.9	33.9
Δ log assets in %	62,784	1.8	17.5	−10.7	−2.5	0.8	4.5	16.2
Δ log PPE in %	62,106	1.9	44.8	−12.4	−2.5	0.6	4.3	18.5
Δ log sales in %	62,815	2.4	57.0	−28.3	−3.2	0.0	7.6	32.9
loan amount in \$mn	8,028	1,169.5	2,664.0	44.0	180.0	442.0	1,100.0	4,500.0
borrowing probability in %	N/A	3.2	3.1	1.0	1.0	2.1	4.1	9.3

Note: This table reports summary statistics for our sample of firms borrowing from US banks. Specifically, it compiles the average *Mean*, standard deviation *Std.*, and the 5, 25, 50, 75 and 95 percentile of several firm-level variables: *current asset ratio* is the ratio of current to total assets, *book leverage* is book debt over total assets, Δ log *debt* is the relative change in firm debt (short-term plus long-term liabilities), Δ log *assets* is the relative change in total assets, Δ log *PPE* is the relative change in property plant and equipment (PPE) net of depreciation, Δ log *sales* is the relative change in total gross sales net of trade and cash discounts, *loan amount* is the aggregate amount of the portion of all syndicated loans that a firm has borrowed in a given quarter from US banks, and *borrowing probability* is the share of quarters during which a firm borrows from US banks in a G10 currency other than US dollars. *#Obs* is the total number of non-missing observations for a given variable. The sample covers the period from January 2000 to March 2024.

III. Global Currency Flows

We first study how institutions' transactions of various currencies respond to US monetary shocks. We then examine how currency risk governs this response before analyzing the persistence of the effect.

A. Immediate Response of Currency Flows to US Monetary Policy

In this section, we examine the contemporaneous response of various institutions' currency transactions in response to an FOMC announcement. In contrast to much of the literature that focuses on intra-day dynamics (for example, Savor and Wilson, 2014; Mueller et al., 2017; Ai and Bansal, 2018), we analyze flows during the whole calendar month that includes the days preceding and succeeding the announcement.

We begin by estimating regressions of an institution's order flow for each currency on our measure of monetary policy surprises to understand how each type of institution responds to policy shocks. We run the time series regression

$$OF(S_{ij,t}) = a_{ij} + \beta_{ij} MPS_t + \epsilon_{ij,t}. \quad (5)$$

We call the estimated slope coefficients, β_{ij}, *flow betas*. They measure in US dollars the magnitude of flows into foreign currency i by institution type j in response to an unexpected one basis point decline in the Federal Funds rate. Because an expansionary shock raises Federal Funds futures prices, we would expect that a an easing of US monetary policy induces a positive inflow into foreign currencies as the opportunity cost of holding dollars increases. Hence, we expect that β_{ij} is positive.

Table 4 tabulates flow betas across our set of nine dollar-based currency pairs and institution types. We order currency pairs by their average carry betas, which approximate their interest rate differentials relative to the US. In the table's last two columns we list each country's average carry and dollar betas.

We start by looking at flow betas across currencies for investment funds. Low carry beta currencies tend to possess negative flow betas, at least in cases when the betas are statistically significant. As carry betas turn negative to positive, flow betas also switch from negative to positive. Thus, funds sell low-risk currencies and purchase high-risk currencies during periods of expansionary US monetary policy. For example, a one basis point unexpected decline in US rates leads to a \$190mn inflow into the Australian dollar. Relative to the USDAUD currency pair's monthly variability of fund flows of \$2,650mn, this amounts to around 7 percent of a standard deviation per basis point surprise.

Funds' response to monetary policy is consistent with their strategic, risk-taking behavior. Figure 3 provides a visualization for their "risk-on" response by scattering carry betas on fund betas. As carry betas shift from negative to positive, so does the direction of foreign currency flows, changing from outflows to inflows. In sum, we find that funds rebalance across currencies by shifting out of safe, low interest rate currencies into risky, high interest rate currencies following expansionary US monetary policy. This heterogeneity of fund flows across currencies is also consistent with the evidence for exchange trade funds: Kroencke, Schmeling, and Schrimpf (2021) show that equity fund flows respond significantly to FOMC announcements, which is in line with investors reacting heterogeneously to monetary policy news.

Turning to other institution types, we do not find evidence of such a "risk-on" response. In particular, corporations tend to have flows that appear to move oppositely to

Table 4. Flow Betas for G10 Currency Pairs

	Corporates	**Funds**	**NBFIs**	**Non-dealer banks**	**Dealer banks**	carry beta	dollar beta
USDJPY	8.04	35.88	14.42	−246.79***	188.45***	−0.25	0.51
	[0.56]	[0.74]	[1.03]	[4.73]	[4.25]		
USDCHF	7.08	23.51	−10.85	−15.52	−4.22	−0.10	0.98
	[0.76]	[0.42]	[0.67]	[0.57]	[0.10]		
USDEUR	31.47	−580.18***	16.15*	−62.86	595.42**	−0.09	1.11
	[0.95]	[4.57]	[1.86]	[0.40]	[2.44]		
USDSEK	4.17**	−30.21***	−2.18	20.67	7.55	0.04	1.34
	[2.54]	[3.14]	[1.38]	[1.03]	[0.51]		
USDGBP	−72.82***	210.39***	−25.46*	27.04	−139.15	0.05	0.87
	[2.90]	[3.38]	[1.76]	[0.18]	[1.29]		
USDNOK	−4.39**	−13.99***	−1.19	−47.26***	66.84***	0.21	1.57
	[2.12]	[3.33]	[1.15]	[4.60]	[6.47]		
USDCAD	2.18	537.22***	25.06	500.92	−1,065.39***	0.28	0.96
	[0.46]	[5.67]	[1.51]	[1.62]	[3.30]		
USDNZD	−1.67	23.94	1.32	−49.58**	26.00***	0.51	1.42
	[1.59]	[1.13]	[1.55]	[2.11]	[2.96]		
USDAUD	−0.02	190.42***	1.03	−213.38***	21.95	0.57	1.44
	[0.00]	[5.23]	[0.20]	[3.42]	[0.64]		

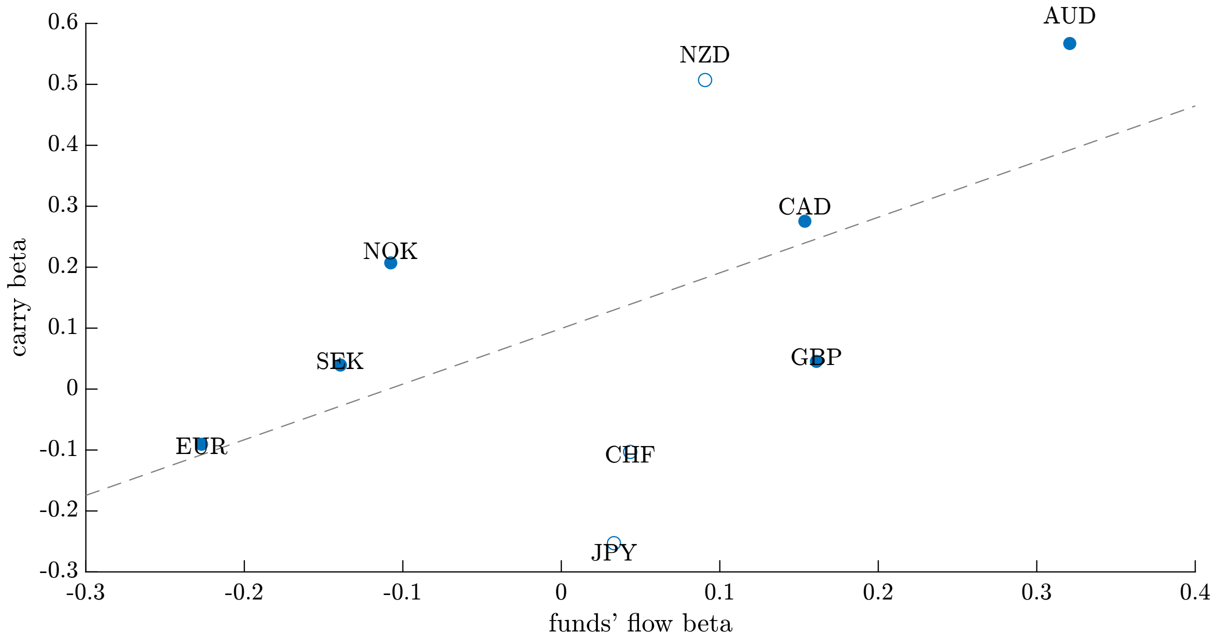
Note: This table reports the β regression coefficients from $OF(S_{ij,t}) = a_{ij} + \beta_{ij} MPS_t + \epsilon_{ij,t}$, where $OF(S_{ij,t})$ is the currency flow in $mn in currency pair i customer group j in month t and MPS_t is our monetary policy shock measure in basis points that we extract from Fed Fund futures rate changes following Kuttner (2001). Currency pairs are sorted by carry betas in ascending order. The column labelled "Dealer banks" is equal to the sum of the first four columns times minus one. The last two columns report the average carry and dollar beta that we compute based on rolling window regressions. Asterisks *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. The numbers inside the brackets are the corresponding test statistics based on robust standard errors (Newey and West, 1987) correcting for heteroskedasticity and serial correlation up to 3 lags. The sample covers the period from September 2012 to March 2024.

fund flows, that is, when US rates fall unexpectedly, corporations appear to buy low interest rate currencies and sell high-rate ones. The economic magnitude of these corporate flows, moreover, is much smaller than those generated by funds.

Among all types of institutions, flows of non-bank financials are the least responsive to monetary policy shocks. All coefficients are statistically insignificant. This is despite their flows being greater in magnitude than those of corporates on average (see Table 2). Differences in investment mandates or horizons could explain why non-bank financials respond differently than investment funds.

Finally, we turn to banks. We distinguish smaller, non-dealer banks from large, dealer banks. We find that non-dealer banks have a statistically significant response for currencies only with negative flow betas. As we expect a lower US rate to induce purchases of foreign currencies, this indicates these banks tend to take the other side of the trade, regardless of the currency's risk. That is, they seem to provide aggregate liquidity. For dealer banks, we find that they tend to purchase low carry beta and sell high carry beta currencies, exactly the opposite of what investment funds do. In this sense, they, too, provide market liquidity, but only to funds. Evans and Lyons (2002a,b) show that dealer

Figure 3. Funds' Currency Flow Betas and Carry Betas



Note: This figure plots the β regression coefficient estimates from $OF(S_{i,t}) = a_i + \beta_i MPS_t + \epsilon_{i,t}$, where $OF(S_{i,t})$ is the currency flow in \$mn in currency pair i by investment funds in month t and MPS_t is our monetary policy shock measure in basis points against the average carry beta. For the regression, both dependent and independent variables are measured in units of standard deviations. Filled dots indicate point estimates that are statistically significant at the 10% confidence level. The inference is based on robust standard errors (Newey and West, 1987) correcting for heteroskedasticity and serial correlation up to 3 lags. The sample covers the period from September 2012 to March 2024.

banks collectively work to offset currency and other exposures by trading with other dealer banks in the inter-dealer market. The CLS data, however, do not allow us to study inter-dealer transactions.

B. Currency Flows by Investment Funds and the FX Factor Structure

In the previous section, we identified investment funds as a major contributor to currency flows surrounding monetary policy announcements. Funds, in particular, appear to rebalance up the spectrum of systematic currency risk following expansionary shocks.

We now proceed to decompose the determinants of investment funds' currency flows. We do this by regressing flows on an interaction of country characteristics, X_i, with monetary policy shock, MPS_t:

$$OF(S_{i,t}) = \mu_i + \alpha_t + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \kappa \mathbf{W}_{i,t} + \epsilon_{i,t}, \tag{6}$$

where the dependent variable is funds' order flow of currency i at time t. We include both country- and time-fixed effects, μ_i and α_t, to control for unobserved heterogeneity at the country-level and for time variation in global factors.

In $\mathbf{W}_{i,t}$ we control for currency liquidity, measured by log change in the relative bid-ask spread, and the exchange rate's log return. Because our construction of currency flows is in dollars, movements in the exchange rate could introduce mechanical variation. To separate changes in currency flows driven by exchange rates from actual flows, we include the exchange rate return to control for this mechanical relationship.

Our interaction term φ is the coefficient of interest. Given that MPS_t is a high-frequency shock, we can interpret X_i as an instrument through which we are shocking currency flows. Thus, these variables indicate which country-level characteristics drive the contemporaneous responses in currency flows, and we consider dollar and carry betas that are known to capture systematic currency risk.

One potential econometric concern is that currency risk, X_i, itself is affected by changes in US monetary policy. But we find no evidence for this to be the case. We summarize these additional results in Section VI.

Table 5 tabulates the results of estimating Eq. (6) with standardized coefficients. Column (1) shows that, as expected, a surprise decline in the Fed Funds rate (an increase in MPS_t) causes an outflow from the US. And vice versa, a surprise tightening induces dollar inflows. The effect, by itself, is statistically insignificant, however.

Column (2) measures this effect once controlling for countries' carry betas. For a country that has a carry beta near zero, like the United Kingdom, the effect of the monetary policy shock on flows is 0.01, effectively zero. That is, despite an easing of US monetary policy, we find no evidence of currency outflows to countries with similar risk characteristics.

Next, we analyze how systematic currency risk impacts the cross-section of currency flows. Raising carry beta by one standard deviation substantially brings out the effect of the response. The effect of the monetary policy shock contributes to $0.01 + 0.09 = 0.10$ of a standard deviation of flows, a multiple of the baseline response. In the context of the Australian dollar, this amounts to a directional flow of $0.1 \times \$2.65\text{bn} = \$0.265\text{bn}$ per one standard deviation move in our monetary policy shock measure.

The more positive the carry beta, the larger is the flow into that risky currency. This response provides a detailed account of the seminal Fama (1984) regression. Fama showed that currencies with high interest rates tend to appreciate, counter to UIP holding. We report evidence on the underlying quantities that drive the price appreciation. Subsequent to a reduction in US interest rates, investment funds' currency flows further push up the price of riskier, high interest rate currencies.

If the carry beta of the country in question is negative, like Japan's, then the foreign currency experiences an outflow that moves into US dollars following the cut in the Federal

Funds rate. For example, a country with a carry beta that is one standard deviation below the mean experiences a net flow of $0.01 - 0.09 = -0.08$ standard deviations, which is therefore an outflow. We emphasize that if the currency's carry beta is sufficiently negative, it can result in net *inflows* to the dollar despite the reduction in US rates.

Collectively, the evidence supports a systematic rebalancing of funds' currency positions and is consistent with the risk-taking channel of monetary policy. Following an unexpected easing in the Federal Funds rate, funds' reshuffle their portfolios by selling low-risk currencies and instead buying high-risk ones, as measured by carry betas.

Turning to dollar betas, we find positive but insignificant effects, at least initially. Column (3) shows that currencies with greater dollar betas are *not* differentially affected by monetary policy compared to currencies with smaller dollar betas. Thus, dollar betas, by themselves, do not seem to explain the response of flows to monetary policy. A possible interpretation is that dollar betas' impact on currency flows is time-invariant, which is consistent with the determinants of the gravity equation in international trade being composed of relatively static variables.

Carry betas therefore appear to be the primary source of systematic currency risk that explains the response of funds' flows across currencies *to monetary policy shocks.* We find similar point estimates in columns (4) and (5) when including both currency and time fixed effects.

Finally, in column (6) we include both dollar and carry betas in addition to time fixed effects. Carry betas retain their explanatory power and the interaction coefficient is boosted from 0.09 to 0.17. The interaction coefficient with dollar betas, however, now displays a statistically significant, negative effect, once we control for carry betas. The negative coefficient indicates that a greater distance from the US correlates with a reduction in flows. This may not be surprising given the classic findings in the gravity literature. As an example, "distance" in gravity refers not only to physical distance but also to differences in common language and customs, impacting the nature of financial markets. As a result, it is plausible to expect an inverse relation between the quantity of currency flows across two countries and their dollar betas, much like the negative relationship between the quantity of trade and their dollar betas in gravity models (Lustig and Richmond, 2019). This reasoning could explain the results on dollar beta.

Given the results on dollar beta it is worth discussing our findings in the context of the literature. Verdelhan (2018) shows that both carry and dollar factors have positive prices of risk; that is, a greater exposure of a currency to either factor would raise its required return. In contrast, we find that a greater dollar beta reduces the flow into the foreign currency, despite them being riskier in a factor sense. The difference could stem from Verdelhan's work concerning prices and ours concerning quantities. After all, it is well known in the gravity literature that trade between countries falls as their distance

Table 5. Currency Flows of Funds and the FX Factor Structure

	(1)	(2)	(3)	(4)	(5)	(6)
carry $\text{beta}_{\text{i,t}}$		0.02		0.00		−0.15
		[0.39]		[0.02]		[1.00]
dollar $\text{beta}_{\text{i,t}}$			0.13		0.14	0.20
			[0.70]		[0.76]	[0.95]
MPS_{t}	0.03	0.01	−0.04			
	[0.86]	[0.26]	[0.43]			
carry $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$		0.09***		0.09***		0.17***
		[2.75]		[2.62]		[4.21]
dollar $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$			0.08		0.07	−0.36***
			[1.13]		[0.95]	[3.68]
$\Delta \log$ bid-ask $\text{spread}_{\text{i,t}}$		−0.03	−0.03	−0.01	−0.02	0.03
		[1.34]	[1.57]	[0.68]	[0.87]	[0.91]
$\Delta \log S_{i,t}$		−0.01	−0.02	−0.02	−0.03	−0.02
		[0.37]	[0.52]	[0.43]	[0.59]	[0.46]
Overall R^2 in %	18.76	19.46	19.25	30.80	30.65	31.85
Avg. #Time periods	139	138	138	138	138	138
#Currencies	9	9	9	9	9	9
Currency FE	yes	yes	yes	yes	yes	yes
Time series FE	no	no	no	yes	yes	yes

Note: This table reports results from fixed effects panel regressions of the form $OF(S_{i,t}) = \mu_i + \alpha_t + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \kappa \mathbf{W}_{i,t} + \epsilon_{i,t}$, where $OF(S_{i,t})$ is the order flow by *funds* in \$bn in currency pair i in month t. $X_{\text{i,t}}$ denotes either the *carry* $\textit{beta}_{\text{i,t}}$ or *dollar* $\textit{beta}_{\text{i,t}}$ that are based on rolling window regressions of currency excess returns on the carry and dollar factor, respectively. MPS_t is our monetary policy shock in basis points that we extract from Fed Fund futures rate changes following Kuttner (2001). $\mathbf{W}_{i,t}$ may include the following control variables: $\Delta \log$ *bid-ask* $\textit{spread}_{\text{i,t}}$ is the log change in the monthly average relative bid-ask spread and $\Delta \log S_{i,t}$ is the log change in the spot exchange rate expressed as the number of foreign currency units per unit of US dollar. Both dependent and independent variables are measured in units of standard deviations. The test statistics based on double clustered (by currencies and time) standard errors, allowing for serial correlation up to 3 lags are reported in brackets. Asterisks *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. The sample covers the period from September 2012 to March 2024.

grows. It appears quantities of funds' currency flows exhibit the same effect.

C. Persistent Response of Funds' FX Flows to US Monetary Policy

We previously established that investment funds respond contemporaneously to monetary policy. However, monetary policy is known to affect the economy with a lag. We now examine the persistence in funds' responses, which is plausibly more informative regarding monetary transmission.

We study the cumulative impact of spot market flows.[10] To isolate the impact of

[10] In the Online Appendix in Section B we study differences in order flow for forward contracts following a monetary policy shock. We find that purchases of forwards are concentrated in near-maturities, consistent with Lustig, Stathopoulos, and Verdelhan (2019). These results do not imply that carry trade activity only has a short-term impact, however, our data do not allow us to see if initial carry trade

currency risk on flows, we form three groups of currencies—low, medium, and high—based on their carry betas and then sum all flows within each group. The point of grouping is to isolate common drivers of currency flows, which will be useful for thinking about persistent responses. By contrast, focusing on individual currencies would allow idiosyncratic noise to contaminate the confidence intervals of the long-run impulse responses.

We estimate the impulse responses of flows to the monetary shock by using local projections following Jordà (2005). For each group g, the local projections are as follows:

$$OF(S^g_{t,t+h}) = \alpha^g_h + \sum_{m=0}^{3} \beta^g_{h,m} MPS_{t-m} + \epsilon^g_{t+h}, \tag{7}$$

where $OF(S^g_{t,t+h})$ is the cumulative currency flow within a group observed h months ahead of the monetary policy shock that occurred at time t.

In Figure 4 we plot the cumulative impulse responses of funds' spot currency flows by reporting the coefficient $\beta^g_{h,0}$ for the low- and high-carry-beta groups. We see that currencies with low carry betas experience an outflow following an easing of US monetary policy. The plots are cumulative flows, so following the initial outflow we see a series of smaller outflows before returning to the average flow. The effect is statistically significant for around four months.

The group of currencies with high carry betas displays a different dynamic: an unexpected easing shock causes an enduring flow from the US into high-risk currencies. The average effect is very persistent, lasting beyond 12 months in our data sample.

Taken together, there is evidence that the safest and riskiest currencies are differentially impacted by US monetary policy. Investment funds sell safe and buy risky currencies. This rebalancing up the risk spectrum of currencies is persistent, despite the transient nature of the monetary shock.

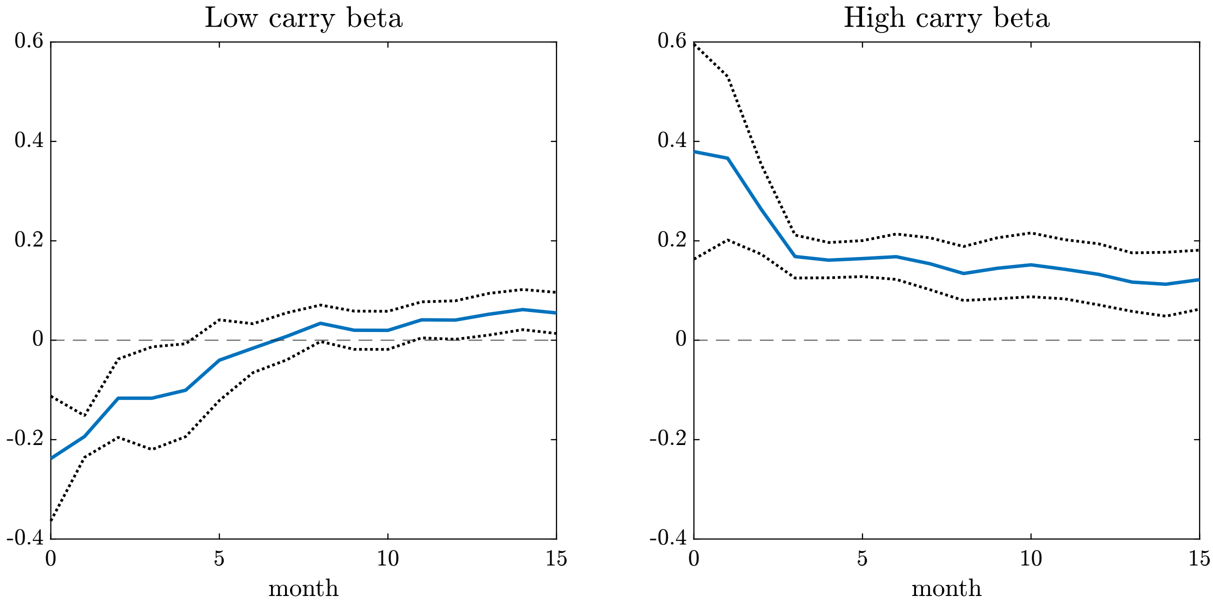
IV. International Bank Lending

Our evidence, so far, shows that investment funds' currency flows are central to global FX markets. But banks, too, play an outsized role, mainly as liquidity providers. It is plausible that banks seek to offset the changes in risk induced by providing liquidity by trading with other banks. But the anonymized structure of the CLS data, unfortunately, does not permit us to track within-bank or between-bank transactions.

Another avenue in which global US banks could change their currency risk exposure is with the foreign loan market. Indeed, global bank loans constitute nearly half of external liabilities of emerging economies (Bräuning and Ivashina, 2020b). More notably, while

positions are rolled over to lengthen the horizon of the trade.

Figure 4. Persistent Effect of Monetary Policy on Spot Currency Flows



Note: This figure plots the impulse response function of currency flows to monetary surprises with local projections (Jordà, 2005) from $OF(S^g_{t,t+h}) = \alpha^g_h + \sum_{m=0}^{3} \beta^g_{h,m} MPS_{t-m} + \epsilon^g_{t+h}$, where $OF(S^g_{t,t+h})$ is the cumulative order flow in currency group g in \$bn after h months. Both dependent and independent variables are in standardized units. Currency groups are formed based on country i's carry beta and MPS_t is our monetary policy shock. The dotted lines mark the 90% confidence bands based on Newey and West (1987) standard errors correcting for the autocorrelation induced by overlapping periods. The sample covers the period from September 2012 to March 2024.

funds typically transact in secondary markets, banks originate loans in primary markets. We therefore now study banks' foreign currency loan origination with an eye towards understanding monetary policy transmission to the international real economy.

A. International Lending in Response to US Monetary Policy

We first explore the response of foreign currency lending to changes in US monetary policy by running the following regression:

$$\log Loan_{i,t} = a_i + \beta_i MPS_t + \gamma_i \Delta \log S_{i,t} + \epsilon_{i,t}, \tag{8}$$

where $\log Loan_{i,t}$ is the log amount lent by US banks to corporations domiciled abroad during month t in currency i in dollars. Since all loan activity in DealScan is reported in US dollars, movements in the dollar exchange rate could mechanically influence loan volumes, so we include log changes in the bilateral spot rate, $\Delta \log S_{i,t}$, to mitigate this mechanical effect.

Our coefficient of interest is β_i, which we call a currency's *credit beta*. It measures the rate of loan growth in a particular foreign currency, such as the Japanese yen, conditional on a positive monetary policy shock of one basis point.

We run Eq. (8) for each currency and plot credit betas on carry betas in Figure 5. We first note that four out of nine currencies display negative credit betas in response to a loosening of US monetary policy. This result supports the findings of Bräuning and Ivashina (2020a), who show that foreign currency lending decreases following a narrowing of the spread for interest on reserves between the United States and abroad. Intuitively, as the opportunity cost of holding reserves falls domestically, US banks substitute away from making international loans toward domestic ones. While Bräuning and Ivashina (2020a) document this effect for a small set of currencies—British pound, Canadian dollar, euro, Japanese yen, and Swiss franc—our results with the G10 sample support this mechanism.

The regression line in Figure 5 is upward sloping and hence, similar to the risk-on pattern that we have seen for investment funds. While funds sell out of low-risk currencies to invest in risky ones following an expansionary shock (see Figure 3), we see that banks, similarly, tilt their lending toward risky currencies following a similar risk-on impetus. Though the key novelty here is that banks' risk-taking behavior takes place in the primary market.

B. International Lending and the FX Factor Structure

We further decompose the drivers of how US banks' foreign currency lending responds to changes in monetary policy using panel regressions. We examine how lending is impacted by country-level characteristics, X_i, that are known to measure currencies' systematic exposures; namely, dollar and carry betas. Formally, we estimate the following panel regression:

$$\log Loan_{i,t} = \mu_i + \alpha_t + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \gamma \Delta \log S_{i,t} + \epsilon_{i,t}, \tag{9}$$

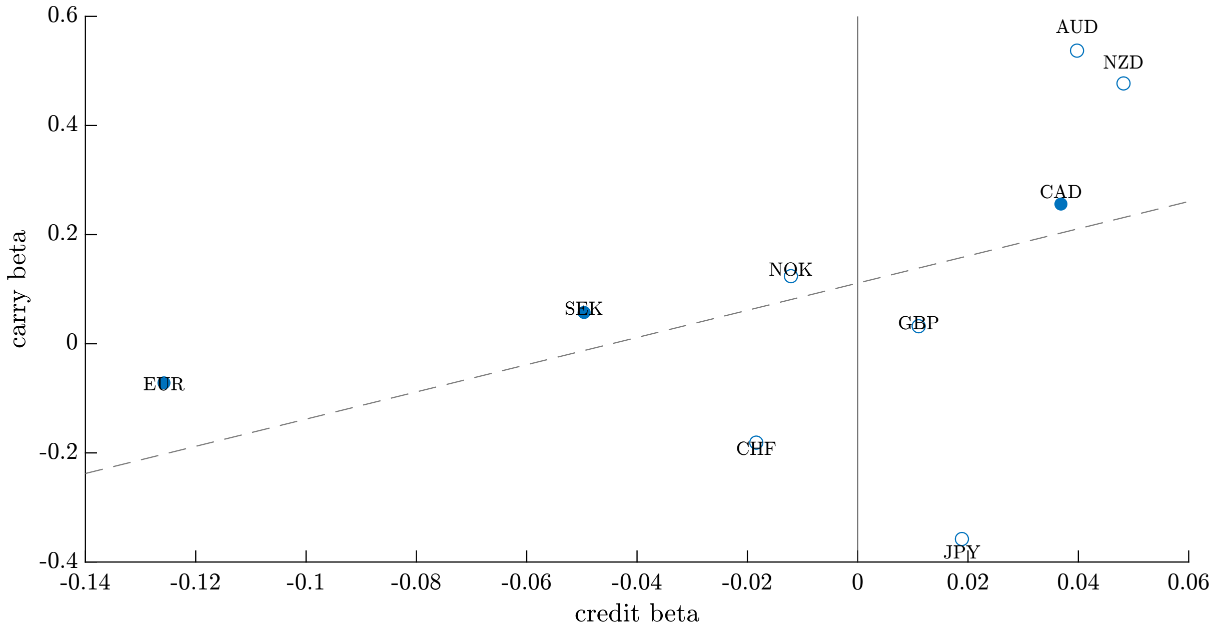
where we include both country- and time-fixed effects, μ_i and α_t. Our interaction term φ is the coefficient of interest and, as before, X_i serves as an instrument through which the monetary policy shock MPS_t is transmitted to foreign loan origination.

Table 6 tabulates the results with standardized regressors. Column (1) produces the average point estimate of the results displayed visually in Figure 5. The coefficient of 0.03 is modestly positive but statistically insignificant.

Column (2) controls for the monetary policy shock interacted with carry betas. As we saw with funds, lending in a currency that has a zero carry beta, and therefore, possesses a similar interest rate as the US, appears to be relatively unresponsive to a change in US monetary policy.

The growth in foreign lending, however, is moderately influenced by the degree of

Figure 5. Foreign Credit Betas and Carry Betas



Note: This figure plots the β regression coefficient estimates from $\log Loan_{i,t} = a_i + \beta_i MPS_t + \gamma_i \Delta \log S_{i,t} + \epsilon_{i,t}$ against the average carry beta. $\log Loan_{i,t}$ is the natural log of the dollar amount lent by global banks headquartered in the US to corporations domiciled abroad in foreign currency i during month t. MPS_t is our monetary policy shock measure in basis points (Kuttner, 2001). $\Delta \log S_{i,t}$ is the log change in the spot exchange rate expressed as the number of foreign currency units per unit of US dollar. For the regression, both dependent and independent variables are measured in units of standard deviations. Filled dots indicate point estimates that are statistically significant at the 10% confidence level. The inference is based on robust standard errors (Newey and West, 1987) correcting for heteroskedasticity and serial correlation up to 3 lags. The sample covers the period from January 2000 to March 2024.

currency risk. Conditional on an unexpected US monetary easing, foreign currencies with greater carry betas experience a marked increase in lending. For example, shifting up across the distribution of countries' carry betas by one-standard deviation raises foreign currency lending by $0.04 + 0.11 = 15$ percent. Conversely, lower carry betas are associated with a decline in lending. Hence, carry betas impact the intensity of banks' loan origination: banks take on more in primary markets by tilting their loan origination toward riskier currencies as measured by their carry exposure.

In column (3) we examine the impact of dollar betas on loan growth. The coefficient estimate is negative and statistically significant, again plausibly reflecting the gravity effects of international trade. In columns (4) and (5), we run more stringent specifications that include time-fixed effects, controlling for omitted time-varying global factors. Both interaction coefficients retain their sign as well as statistical significance.

Finally, in column (6) we project loan growth onto interactions of the monetary shock with both carry and dollar betas. The magnitudes of coefficients for both betas has grown by about 50 percent from when evaluated separately. Statistical significance for both coefficients, too, has strengthened. Overall, the results are consistent with carry betas measuring the risk aspect of the loan allocation, whereas dollar betas capture how gravity effects impede these loan origination flows.

In sum, global US banks reshuffle their foreign currency lending in response to changes in Federal Reserve policy. Specifically, we see that banks tilt their loan origination toward currencies that have greater systematic risk. In cases in which currency risk is particularly pronounced, the risk-taking channel could completely offset and even reverse the decline of foreign loans driven by the reduced opportunity cost of holding US reserves.

Table 6. International Lending and the FX Factor Structure

	(1)	(2)	(3)	(4)	(5)	(6)
carry $\text{beta}_{\text{i,t}}$		−0.33		−0.69		−1.37
		[1.22]		[1.59]		[1.44]
dollar $\text{beta}_{\text{i,t}}$			0.41		0.41	0.84
			[0.99]		[1.21]	[1.24]
MPS_{t}	0.03	0.04	0.40***			
	[0.52]	[0.96]	[3.62]			
carry $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$		0.11*		0.11***		0.17***
		[1.81]		[2.65]		[3.01]
dollar $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$			−0.38**		−0.49**	−0.68**
			[2.04]		[2.13]	[2.14]
$\Delta \log S_{i,t}$	−0.08	−0.08	−0.09	−0.06	−0.08	−0.07
	[0.71]	[0.75]	[0.76]	[0.36]	[0.43]	[0.43]
Overall R^2 in %	57.95	58.02	58.02	63.00	62.99	63.21
Avg. #Time periods	291	291	291	291	291	291
#Currencies	9	9	9	9	9	9
Currency FE	yes	yes	yes	yes	yes	yes
Time series FE	no	no	no	yes	yes	yes

Note: This table reports results from fixed effects panel regressions of the form $\log Loan_{i,t} = \mu_i + \alpha_t + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \gamma \Delta \log S_{i,t} + \epsilon_{i,t}$, where $\log Loan_{i,t}$ is the natural log of the dollar amount lent by banks headquartered in the US to corporations domiciled abroad in currency i during month t. $X_{\text{i,t}}$ denotes either the *carry* $beta_{\text{i,t}}$ or *dollar* $beta_{\text{i,t}}$ that are based on rolling window regressions of currency excess returns on the carry and dollar factor, respectively. MPS_t is our monetary policy shock in basis points that we extract from Fed Fund futures rate changes following Kuttner (2001). $\Delta s_{i,t}$ is the log change in the spot exchange rate expressed as the number of foreign currency units per unit of US dollar. The independent variables are measured in units of standard deviations. The test statistics based on double clustered (by currencies and time) standard errors, allowing for first-order serial correlation are reported in brackets. Asterisks *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. The sample spans from January 2000 to March 2024.

V. Firm-Level Outcomes

So far, we have documented evidence that is consistent with the risk-taking channel of monetary policy: following an unexpected easing of monetary policy, both funds and banks tilt away from currencies that are safe toward ones that are risky. But we have not yet showed evidence of transmission to the real economy. To address this, we leverage that banks reallocate in the primary market for loan originations, allowing us to test for real effects within the set of firms borrowing from US banks.

Our empirical strategy is to test whether foreign firms domiciled outside of the US that are exposed to high-risk currencies are impacted differently than firms exposed to low-risk currencies. We do this in two steps. We first test what effect borrowing has on firm's outcomes. We then explain how much is borrowed by a firm following a monetary shock and conditioning on the firm's currency exposure.

We first need to define what a firm's currency exposure is. We choose to measure exposure based on the reporting currency of the firm. A firm's reporting currency is the currency in which the firm primarily generates cash flows, basically its operating currency. We expect, then, that firms that report in high-risk currencies and borrow from a global US bank are more likely to respond to US monetary policy than firms that report in low-risk currencies.

The reporting currency is often the same as the currency of the country in which the firm is domiciled. About 11.6 percent of firms in our sample report using a currency that is not the same as the currency of their domicile country. This distinction allows us to control for country specific time-varying effects and isolate the impact of a firm's currency, rather than its country, on its borrowing. Though our results are qualitatively similar when identifying a firm's currency exposure based on their domicile currency.

To be consistent with the quarterly balance sheet data from Compustat, all loans are aggregated at the firm-quarter level. For firms that borrow more than once per quarter, we keep only the loan(s) issued in the firm's reporting currency. But our results are robust to excluding these firm-quarter observations from our sample.

A. How Borrowing Impacts a Firm's Leverage and Investment

We start by testing what impact borrowing has on a firm's outcomes, both contemporaneously and in future periods. We run the following firm-level panel regression:

$$\log y_{j,i,s} = \mu_j + \alpha_t + \beta D_{j,i,t} + \gamma \log S_{i,t} + \kappa \mathbf{W}_{j,i,t} + \epsilon_{j,i,s}, \tag{10}$$

where $\log y_{j,i,s}$ is the log value of a firm-level outcome variable y for firm j borrowing in currency i at time s. We set s to be contemporaneous, $s = t$, or one-quarter ahead,

$s = t + 1$. Our control variables are the log change in the spot exchange rate, $\Delta \log S_{i,t}$, and $\mathbf{W}_{j,i,t}$, which includes log assets, the current ratio, and the change in log sales. Firm- and time-fixed effects, μ_j and α_t, control for unobserved heterogeneity at the firm-level and for time variation in global factors.

Our main regressor is $D_{j,i,t}$, a dummy variable that is equal to one if firm j has borrowed in currency i via a syndicate in quarter t and this syndicate involves at least one bank that is domiciled in the US. Against this backdrop, a statistically significant β coefficient indicates that the foreign firm's outcome in question responds to a syndicated loan that involves at least one US bank.

Table 7 shows the results of estimating Eq. (10) for three firm-level outcome variables (in log differences): total debt (short- plus long-term liabilities), total assets, and PPE net of depreciation. Contemporaneously, we find that the all β coefficients are positive and statistically significant. For instance, firms that borrow from syndicates involving US banks experience on average a 7.57, 3.63, and 2.62 percentage point increase in debt, assets, and PPE, respectively. The growth in book debt confirms that asset growth is driven by additional borrowing, not refinancing. And the fact that firm debt is growing faster than total assets implies an increase in firm leverage. The increase in PPE indicates that the new funding is raised to finance investment into tangible assets.

Projecting one quarter ahead, the impact of borrowing from a US syndicate is weaker. But it is still economically meaningful and exhibits around one-quarter of the contemporaneous effect. It is natural to ask for how long these effects persist. We study this question by estimating Eq. (10) using local projection analysis (Jordà, 2005) that maps out the cumulative response.

In Figure 6 we plot the cumulative impulse responses of three firm-level outcome variables by reporting the β coefficients in Eq. (10). Firms' debt, assets, and PPE increase following a borrowing from a syndicated loan involving US banks. After an initial increase in all three variables, we see a series of smaller additional contributions before returning to the average growth rate after four to six quarters.

B. How Firms' Borrowings Responds to US Monetary Policy

After establishing that borrowing impacts leverage and investment, we inquire how currency risk affects the size of the loan. To isolate the impact of US monetary policy on the granting of this loan, we cumulate the portion of a syndicated loan that can be attributed to borrowing from US banks in a given quarter t and currency i. And for any given firm j we only consider loans that are issued in the same currency as the reporting currency of the firm. We do so because we want to distinguish between firms borrowing in high- relative to low-risk currencies. Specifically, we run a regression that explains foreign lending

Table 7. Firm-Level Response to Syndicated Loan Borrowing

	$\log \text{debt}_{j,i,t}$	$\log \text{assets}_{j,i,t}$	$\log \text{PPE}_{j,i,t}$	$\log \text{debt}_{j,i,t+1}$	$\log \text{assets}_{j,i,t+1}$	$\log \text{PPE}_{j,i,t+1}$
$D_{j,i,t}$	7.57***	3.63***	2.62***	1.91*	0.72*	0.71
	[5.66]	[6.73]	[4.43]	[1.82]	[1.70]	[1.33]
$\Delta \log S_{i,t}$	−35.80***	−30.91**	−31.13**	−17.41*	−9.86**	−11.42**
	[2.61]	[2.31]	[2.16]	[1.65]	[2.08]	[2.22]
$\log \text{assets}_{j,i,t-1}$	−3.13***	−2.71***	−1.43***	−2.52***	−2.12***	−1.41***
	[6.37]	[7.30]	[3.93]	[5.41]	[6.21]	[4.24]
current asset $\text{ratio}_{j,i,t-1}$	−6.20*	−5.40*	11.60***	−1.60	−0.40	9.25***
	[1.66]	[1.85]	[4.81]	[0.48]	[0.16]	[3.94]
$\Delta \log \text{sales}_{j,i,t-1}$	0.00	0.00	0.00	0.01	0.00	0.01
	[1.03]	[0.42]	[0.25]	[1.21]	[0.82]	[1.48]
Overall R^2 in %	5.61	19.60	14.47	5.00	17.89	13.94
Avg. #Time periods	95	95	95	94	94	94
#Firms	1094	1112	1111	1092	1110	1109
Firm FE	yes	yes	yes	yes	yes	yes
Time series FE	yes	yes	yes	yes	yes	yes

Note: This table reports results from fixed effects panel regressions of the form $\Delta \log y_{j,i,t} = \mu_j + \alpha_t + \beta D_{j,i,t} + \gamma \log S_{i,t} + \kappa \mathbf{W}_{j,i,t} + \epsilon_{j,i,t}$, where $\Delta \log y_{j,i,t}$ is the quarterly growth rate (in percentage points) of a firm-level outcome variable y (see column header) for firm j borrowing in currency i. $\Delta \log S_{i,t}$ is the log change in the spot exchange rate. $\mathbf{W}_{j,i,t}$ includes the following control variables: $\log \text{assets}_{j,i,t-1}$ (total value of assets reported on the balance sheet), current asset $\text{ratio}_{j,i,t-1}$ (ratio of current to total assets), and $\Delta \log \text{sales}_{j,i,t-1}$ (total gross sales net of trade and cash discounts). $D_{j,i,t}$ is a dummy variable that is equal to unity if firm j has borrowed via a syndicate in quarter t and this syndicate involves at least one bank that is domiciled in the US. The test statistics based on double clustered standard errors (by firm and time) allowing for first order serial correlation are reported in brackets. Asterisks *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. The sample spans from September 2012 to March 2024.

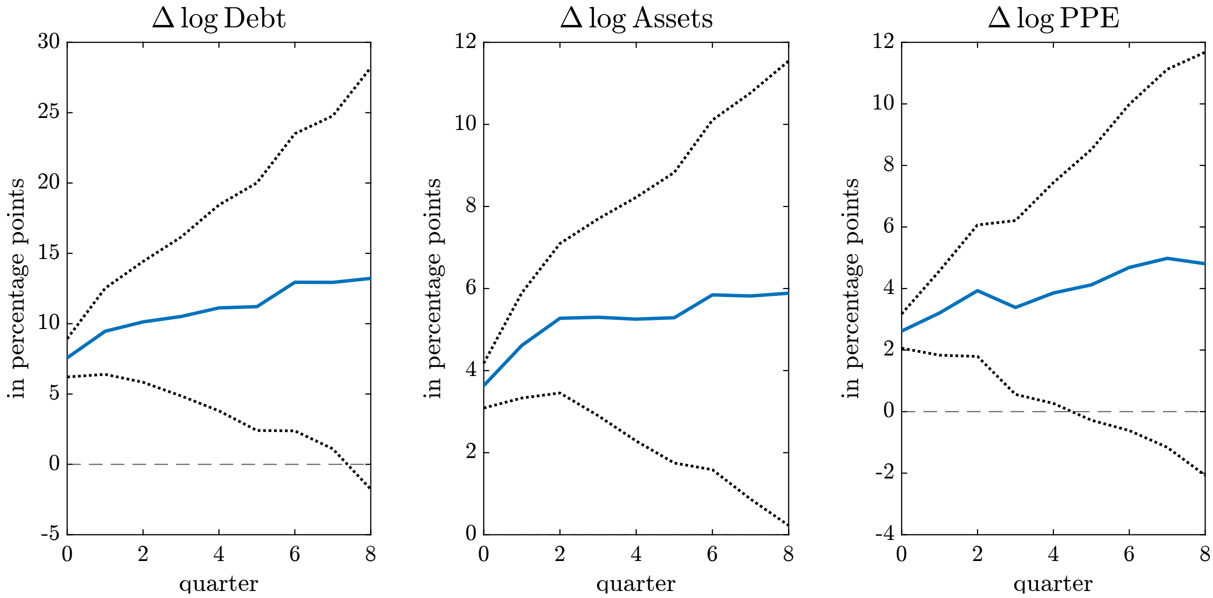
growth around US monetary policy changes conditional on the loan's currency:

$$\log Loan_{j,i,c,t} = \mu_j + \alpha_{c,t} + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \gamma \Delta \log S_{i,t} + \kappa \mathbf{W}_{j,i,t} + \epsilon_{i,j,c,t}. \tag{11}$$

As before, our currency risk measures of dollar and carry betas are in $X_{i,t}$, which we attribute to each firm based on its reporting currency. Our monetary policy shock is MPS_t. Our controls, $\Delta \log S_{i,t}$ and $\mathbf{W}_{j,i,t}$, are the same as in Eq. (10). We always control for firm fixed effects, μ_j, and we either use time fixed effects, $\alpha_{c,t} = \alpha_t$, or country-times-quarter fixed effects, $\alpha_{c,t}$, to control for time-variation in a given country's macroeconomic conditions.

The more stringent country-quarter fixed effects, $\alpha_{c,t}$ help us to isolate the monetary transmission that comes through the supply of bank loans. This is because this fixed effect will absorb all variation due to countries' specific economic conditions. Hence, the only effect remaining will come from the supply of the new syndicated loan involving a global US bank. Importantly, a firm's country c does not necessarily align with its

Figure 6. Dynamics of Firm-Level Response to Syndicated Loan Borrowing



Note: This figure plots the cumulative impulse response of three firm-level outcome variables (i.e., debt, asset, and PPE growth) with local projections (Jordà, 2005) from $\Delta \log y_{j,i,t+h} = \mu_j^h + \alpha_t^h + \beta^h D_{j,i,t} + \gamma^h \log S_{i,t} + \kappa^h \mathbf{W}_{j,i,t} + \epsilon_{j,t+h}$, where $\Delta \log y_{j,i,t}$ is the quarterly growth rate (in percentage points) of a firm-level outcome variable y for firm j borrowing in currency i. $\Delta \log S_{i,t}$ is the log change in the spot exchange rate. $\mathbf{W}_{j,i,t}$ includes the following control variables: $\log \text{assets}_{j,i,t-1}$ (total value of assets reported on the balance sheet), current asset $\text{ratio}_{j,i,t-1}$ (ratio of current to total assets), and $\Delta \log \text{sales}_{j,i,t-1}$ (total gross sales net of trade and cash discounts). $D_{j,i,t}$ is a dummy variable that is equal to unity if firm j has borrowed via a syndicate in quarter t and this syndicate involves at least one bank that is domiciled in the US. The dotted lines mark the 90% confidence bands based on Newey and West (1987) standard errors correcting for the autocorrelation induced by overlapping periods. The sample covers the period from September 2012 to March 2024.

reported currency i. Hence, our main coefficient of interest, φ, will be identified based on firms borrowing in different currencies in the *same* country. The coefficient captures the differences in syndicated loan origination to firms exposed to high relative to low-risk currencies following an unexpected easing of US monetary policy.

Table 8 reports the results from estimating Eq. (11) across various specifications. We find that firms exposed to high carry beta currencies receive more loans than firms that are exposed to low carry beta currencies following an easing of US monetary policy. Specifically, we find that a one standard deviation easing of US monetary policy is associated with a 5 to 20 percent increase in syndicated loans for firms borrowing in currencies with carry betas that are one standard deviation above average.

The interaction effects with respect to dollar betas are either negative or statistically insignificant. This underscores our earlier finding that dollar betas do not line up with foreign currency flows in terms of their response to an easing of US monetary policy. When including both carry and dollar betas in the same specification, the carry betas drive out the dollar betas when examining the response within a country-quarter.

Taken together, our results show that firms borrowing in high carry beta currencies experience a credit expansion and an up-tick in real investment activity following an easing of US monetary policy. We argue that this is because firms that are exposed to high carry beta currencies experience an unanticipated positive loan supply shock following an easing of US monetary policy.

Table 8. Firm-Level Foreign Currency Borrowing and the FX Factor Structure

	(1)	(2)	(3)	(4)	(5)	(6)
carry $\text{beta}_{\text{i,t}}$	−0.05*		0.01	−0.13***		−0.08***
	[1.78]		[0.47]	[7.11]		[21.22]
dollar $\text{beta}_{\text{i,t}}$		−0.12***	−0.12***		−0.21***	−0.20***
		[3.31]	[3.20]		[3.99]	[3.97]
MPS_{t}				0.11	0.13	0.00
				[1.31]	[0.75]	[0.02]
carry $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$	0.05***		0.05***	0.19**		0.18**
	[3.33]		[2.93]	[2.30]		[2.45]
dollar $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$		−0.11***	−0.09***		−0.08	0.06
		[3.54]	[3.88]		[0.78]	[1.59]
$\log S_{i,t}$	−0.21	−0.26*	−0.27*	−0.37***	−0.48***	−0.50***
	[1.32]	[1.68]	[1.68]	[3.80]	[2.99]	[2.99]
log $\text{assets}_{j,t-1}$	0.18***	0.19***	0.19***	0.21***	0.22***	0.22***
	[4.32]	[4.53]	[4.57]	[4.84]	[4.85]	[4.90]
current asset $\text{ratio}_{j,t-1}$	−0.02	−0.01	−0.01	−0.01	−0.01	−0.01
	[0.74]	[0.49]	[0.46]	[0.40]	[0.21]	[0.20]
Δ log $\text{sales}_{j,t-1}$	−0.01**	−0.01**	−0.01**	−0.01**	−0.01**	−0.01**
	[2.36]	[2.49]	[2.50]	[2.49]	[2.54]	[2.55]
Overall R^2 in %	4.32	4.36	4.37	3.85	3.85	3.87
Avg. #Time periods	95	95	95	95	95	95
#Firms	1115	1115	1115	1115	1115	1115
Firm FE	yes	yes	yes	yes	yes	yes
Time series FE	yes	yes	yes	no	no	no
Country × quarter FE	no	no	no	yes	yes	yes

Note: This table reports results from fixed effects panel regressions of the form $\log Loan_{j,i,t} = \mu_j + \alpha_{c,t} + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \gamma \Delta \log S_{i,t} + \kappa \mathbf{W}_{j,i,t} + \epsilon_{i,j,t}$, where the dependent variable $Loan_{j,i,t}$ is computed as follows: for a given firm j we cumulate the portion of syndicated loans that can be attributed to borrowing from US banks in a given quarter t and currency i, where currency i has to be the same as the reporting currency of the firm. As before, $X_{\text{i,t}}$ denotes either the *carry beta*$_{\text{i,t}}$ or *dollar beta*$_{\text{i,t}}$ and we also attribute these dollar and carry betas to each firm based on the reporting currency of the firm. MPS_t is our monetary policy shock in basis points following Kuttner (2001). $\Delta \log S_{i,t}$ is the log change in the spot exchange rate and $\mathbf{W}_{j,i,t}$ includes the same control variables as in Eq. (10). μ_j and $\alpha_{c,t}$ denote firm- and quarter times country fixed effects, respectively. The test statistics based on double clustered standard errors (by firm and time) are reported in brackets. Asterisks *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. The sample spans from September 2012 to March 2024.

VI. Extensions and Robustness

Here we summarize robustness checks and additional analyses supporting our main findings. Specifically, we study i) economic sources of currency risk), ii) persistence in currency risk factors, iii) other FX risk factors, iv) contractionary vs expansionary monetary policy shocks, v) other central banks' reactions to US monetary policy, vi) alternative measures of monetary policy shocks, and vii) European monetary policy shocks.

A. Deeper Economic Sources of Currency Risk

We explore the deeper economic determinants of the dollar and carry exposures by running our panel regressions with country-level risk characteristics known to explain them. In particular, we focus on the more recent literature that considers interest rate differentials (Lustig et al., 2011), size (Hassan, 2013), downside betas (Lettau, Maggiori, and Weber, 2014), global imbalances (IMB) betas (Della Corte et al., 2016), trade composition (Ready et al., 2017), trade network centrality (Richmond, 2019), and term premia (Andrews, Colacito, Croce, and Gavazzoni, 2024). Table 9 presents the results from extending our findings in Table 5 to these sources of country-level risk.

Countries that have higher interest rates as measured by their forward discount ($f_i - s_i$), that are more peripheral in the global trade network, that have a greater carry slope expected return, that are smaller economies, and that tend to export commodities and import finished goods all display responses that are economically comparable to our baseline results in column (1) in terms of economic magnitude. For our sample, we do not find an identifiable response emanating from heterogeneous exposures to global trade imbalances (i.e., IMB beta) or downside risk (i.e., downside beta). The result concerning global imbalances is in line with Della Corte et al. (2016), showing that the riskiest countries in terms of net foreign asset positions are not necessarily the countries with the highest interest rates. Moreover, in unreported results we show that the carry betas drive out any other economic sources of risk, except for size, in a horse race.

In sum, all of these measures above confirm that currency flows are guided by currency risk, and that these flows are governed by the magnitude of risk. Collectively, they are consistent with our paper's central idea that systematic currency risk shapes the response of currency flows to monetary policy.

B. Persistence in Currency Exposures

One possible concern is that currency risk characteristics are endogenous and quickly respond to monetary policy shocks. These characteristics of currency risk, however, are very persistent over time. In particular, Lustig et al. (2011) and Hassan and Mano (2018)

Table 9. Currency Flows of Funds and a Comparison of Currency Risks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\mathrm{MPS_t}$	0.01	0.01	0.04	0.10**	−0.03	0.09**	0.12***	−0.03
	[0.26]	[1.01]	[1.11]	[2.07]	[0.46]	[2.06]	[2.83]	[1.17]
carry $\mathrm{beta_{i,t}} \times \mathrm{MPS_t}$	0.09***							
	[2.75]							
IMB $\mathrm{beta_{i,t}} \times \mathrm{MPS_t}$		−0.01						
		[0.51]						
downside $\mathrm{beta_{i,t}} \times \mathrm{MPS_t}$			0.01					
			[0.71]					
$f_{i,t} - s_{i,t} \times \mathrm{MPS_t}$				0.09**				
				[2.01]				
$\mathrm{centrality_{i,t}} \times \mathrm{MPS_t}$					−0.08			
					[1.40]			
term $\mathrm{premium_{i,t}} \times \mathrm{MPS_t}$						0.09		
						[1.60]		
$\mathrm{size_{i,t}} \times \mathrm{MPS_t}$							−0.14***	
							[12.90]	
import $\mathrm{ratio_{i,t}} \times \mathrm{MPS_t}$								0.07***
								[4.52]
Δ log bid-ask $\mathrm{spread_{i,t}}$	−0.03	0.00	−0.03	−0.03	−0.04	−0.03	−0.04*	−0.01
	[1.34]	[0.61]	[1.48]	[1.56]	[1.62]	[1.62]	[1.69]	[1.61]
$\Delta \log S_{i,t}$	−0.01	−0.03	−0.02	−0.02	−0.02	−0.02	−0.01	−0.02
	[0.37]	[0.85]	[0.45]	[0.52]	[0.50]	[0.49]	[0.39]	[0.77]
Overall R^2 in %	19.46	34.52	19.18	19.22	19.73	19.34	21.69	33.57
Avg. #Time periods	138	94	138	138	138	138	135	99
#Currencies	9	9	9	9	9	9	8	9
Currency FE	yes	yes	yes	yes	yes	yes	yes	yes

Note: This table reports results from fixed effects panel regressions of the form $OF(S_{i,t}) = \mu_i + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \kappa \mathbf{W}_{i,t} + \epsilon_{i,t}$, where $OF(S_{i,t})$ is the order flow by *funds* in \$bn in currency pair i in month t. $X_{\mathrm{i,t}}$ denotes various measure of country level risk characteristics. For conciseness, we only report the β and φ coefficients. MPS_t is our monetary policy shock in basis points that we extract from Fed Fund futures rate changes following Kuttner (2001). $\mathbf{W}_{i,t}$ may include the following control variables: Δ log *bid-ask spread*$_{\mathrm{i,t}}$ is the log change in the monthly average relative bid-ask spread and $\Delta \log S_{i,t}$ is the log change in the spot exchange rate expressed as the number of foreign currency units per unit of US dollar. Both dependent and independent variables are measured in units of standard deviations. The test statistics based on double clustered (by currencies and time) standard errors, allowing for serial correlation up to 3 lags are reported in brackets. Asterisks *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. The sample spans from September 2012 to March 2024.

show that more than half of the carry trade return is driven by an unconditional sorting based on interest rate differentials. Furthermore, Lustig and Richmond (2019) report that dollar betas are well-explained by time-invariant variables with a gravity interpretation like geographic distance and common languages.

We treat dollar and carry betas as pre-determined in the econometric sense. The evidence we give in the Online Appendix support this view. First, we document in Table C.1 that exposures are persistent. First-order autocorrelation coefficients cluster around 0.98 for both dollar and carry betas. Moreover, there is compelling evidence that the cross-sectional ranking of currencies is stable over time. For instance, the Swiss franc spends 86 percent of its time in lowest carry-beta portfolio, whereas the Australian dollar is always part of the highest. Similar patterns exist for dollar betas.

Second, we show in Table C.2 that carry and dollar betas are virtually uncorrelated with monetary policy shocks at the monthly frequency. In particular, we find that none of the dollar betas responds significantly to changes in US monetary policy at the monthly frequency. Turning to carry betas, we see that only the USDNZD responds significantly negatively to an easing of US monetary policy.

Third, we replicate our analysis in Tables 5 and 6, but instead of using carry and dollar betas themselves, we transform the betas into a relative cross-sectional rank score (where a higher beta corresponds to a higher rank score). We show in Tables C.4 and C.11 that our key results are qualitatively unchanged. Thus the ordering of currency risk across the cross-section is at the heart of our results.

C. Other Currency Risk Factors

The currency asset pricing literature has identified several sources of currency risk that are not subsumed by the carry factor: Menkhoff, Sarno, Schmeling, and Schrimpf (2012b) create portfolios based on past winner and loser currencies (we consider one-, three-, and twelve-months momentum), Menkhoff, Sarno, Schmeling, and Schrimpf (2017) sort currencies into portfolios based on changes in the real exchange rate, Colacito, Riddiough, and Sarno (2020) form portfolios based on the difference between the actual and potential output (industrial production), and Rafferty (2012) sorts currencies based on their exposure to a global skewness measure. We replicate these portfolio sorts and compute individual currencies' exposure to these factors using rolling window regressions in the spirit of Eq. (1); where we replace the carry factor by one of the aforementioned FX risk factors.

Table 10 shows that currency risk factor that are orthogonal to the carry trade cannot explain the cross-sectional differences in how investment funds' currency flows respond to monetary policy shocks. Specifically, the interaction terms for currency momentum are negative and statistically significant for the one-month maturity, confirming that the risk-on pattern in Figure 3 cannot be explained by a simple trend-chasing behavior that is long past winner and short past loser currencies. We find a similar patter for business cycle strength (i.e., output gap beta). Moreover, the risk-on pattern is largely unrelated to differences in real exchange rate value, exposure to global skewness risk, and longer bouts momentum (three and twelve months).

Table 10. Currency Flows of Funds and a Comparison of Currency Risks

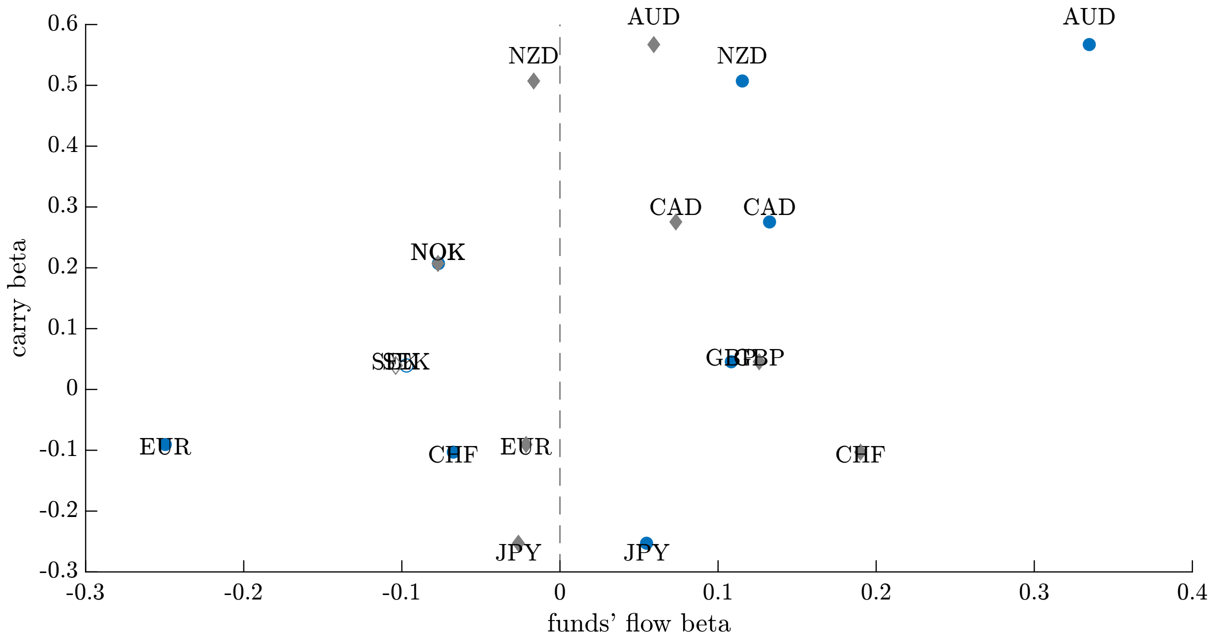
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\mathrm{MPS_t}$	0.01	0.01	0.02	0.01	−0.01	0.05*	0.00
	[0.26]	[0.36]	[0.41]	[0.10]	[0.22]	[1.76]	[0.13]
carry $\mathrm{beta_{i,t}} \times \mathrm{MPS_t}$	0.09***						
	[2.75]						
1M momentum $\mathrm{beta_{i,t}} \times \mathrm{MPS_t}$		−0.03***					
		[2.77]					
3M momentum $\mathrm{beta_{i,t}} \times \mathrm{MPS_t}$			−0.03				
			[0.85]				
1Y momentum $\mathrm{beta_{i,t}} \times \mathrm{MPS_t}$				−0.05			
				[1.31]			
value $\mathrm{beta_{i,t}} \times \mathrm{MPS_t}$					0.06		
					[1.12]		
output gap $\mathrm{beta_{i,t}} \times \mathrm{MPS_t}$						−0.03***	
						[5.93]	
skewness $\mathrm{beta_{i,t}} \times \mathrm{MPS_t}$							0.05
							[1.48]
$\Delta \log$ bid-ask $\mathrm{spread_{i,t}}$	−0.03	−0.03*	−0.03	−0.03	−0.03*	−0.02	−0.02
	[1.34]	[1.69]	[1.14]	[1.32]	[1.67]	[1.18]	[1.48]
$\Delta \log S_{i,t}$	−0.01	−0.02	−0.02	−0.03	−0.02	−0.02	−0.02
	[0.37]	[0.65]	[0.61]	[0.84]	[0.59]	[0.60]	[0.69]
Overall R^2 in %	19.46	19.56	19.49	21.81	19.14	19.72	20.24
Avg. #Time periods	138	138	138	138	138	138	138
#Currencies	9	9	9	9	9	9	8
Currency FE	yes	yes	yes	yes	yes	yes	yes

Note: This table reports results from fixed effects panel regressions of the form $OF(S_{i,t}) = \mu_i + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \kappa \mathbf{W}_{i,t} + \epsilon_{i,t}$, where $OF(S_{i,t})$ is the order flow by *funds* in \$bn in currency pair i in month t. $\mathrm{X_{i,t}}$ denotes the exposure (i.e., beta) to various FX risk factors. For conciseness, we only report the β and φ coefficients. MPS_t is our monetary policy shock in basis points that we extract from Fed Fund futures rate changes following Kuttner (2001). $\mathbf{W}_{i,t}$ may include the following control variables: $\Delta \log$ *bid-ask spread*$_{\mathrm{i,t}}$ is the log change in the monthly average relative bid-ask spread and $\Delta \log S_{i,t}$ is the log change in the spot exchange rate expressed as the number of foreign currency units per unit of US dollar. Both dependent and independent variables are measured in units of standard deviations. The test statistics based on double clustered (by currencies and time) standard errors, allowing for serial correlation up to 3 lags are reported in brackets. Asterisks *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. The sample spans from September 2012 to March 2024.

D. Expansionary and Contractionary Monetary Policy

Here we split our sample into periods of positive and negative monetary policy shocks. Specifically, we replicate Figure 3 for investment funds, distinguishing between periods of easing and tightening of US monetary policy. The key observation is that monetary policy shocks have a stronger impact on currency flows when US monetary policy is easing. This is visually apparent as the flow betas of both high- and low-carry-beta currencies are closer to zero conditional on times of monetary policy tightening. This asymmetry is consistent with the intermediary asset pricing literature: a tightening of US monetary policy is associated with higher balance sheet costs for a financial intermediary operating under a Value-at-Risk constraint, resulting into a deterioration of market liquidity and higher transaction costs (Huang, Ranaldo, Schrimpf, and Somogyi, 2021).

Figure 7. Currency Flow Betas and Carry Betas — Monetary Easing and Tightening



Note: This figure plots the β and γ regression coefficients from $OF(S_{i,t}) = a_i + \beta_i MPS_t \times (MPS_t \geq 0) + \gamma_i MPS_t \times (MPS_t \leq 0) + \epsilon_{i,t}$ against the average carry beta. $OF(S_{i,t})$ is the spot order flow in \$mn in currency pair i by investment funds in month t and MPS_t is our monetary policy shock measure in basis points. For the regression, both dependent and independent variables are measured in units of standard deviations. The β and γ coefficients are shown as blue dots and grey diamonds, respectively. Filled dots or diamonds indicate point estimates that are statistically significant at the 10% confidence level. The inference is based on robust standard errors (Newey and West, 1987) correcting for heteroskedasticity and serial correlation up to 3 lags. The sample covers the period from September 2012 to March 2024.

E. Other Central Banks' Reactions to US Monetary Policy

It could be that what we find is not consistent with the risk-taking channel of US monetary policy. Rather, it could be that foreign central banks tend to react shortly after FOMC announcements in a predictable, systematic way and that this explains our results. For instance, if in response to an easing of US monetary policy central banks of high currency risk countries were to hike interest rates, whereas central banks of low-risk countries were to cut rates, then this could generate a similar pattern to the one in Figure 3. Funds would be simply chasing expected risk-free returns, rather than taking exposure to currency risk.

To test this alternative story, we predict foreign policy rate changes using changes in the Federal Funds target rate interacted with our currency risk exposures (carry and dollar betas):

$$\Delta y_{i,t} = \mu_i + \alpha_t + \beta \Delta FFR_{t-1} + \gamma X_{i,t} + \varphi(X_{i,t} \times \Delta FFR_{t-1}) + \epsilon_{i,t}, \tag{12}$$

where the dependent variable is the change in the policy rate by the foreign central bank of country i at time t and ΔFFR_{t-1} is the change in the Federal Fund target rate last month. We include both country- and time-fixed effects μ_i and α_t, respectively.

Table 11 presents the results from estimating Eq. (12) and provides evidence against the alternative story. This is because the interaction coefficients are estimated to be positive. When the Fed cuts rates, countries with higher carry or dollar exposures, like Australia, tend to cut more, all else equal; whereas countries with negative carry exposures, like Japan, tend to cut less or even raise rates. These patterns are opposite of what the alternative story would predict.

Table 11. Predicting Foreign Policy Rates with Fed Fund Rates

	(1)	(2)	(3)	(4)	(5)
Δ FFR$_{t-1}$	0.23**	0.23**	0.24		
	[2.02]	[2.31]	[0.60]		
carry beta$_{i,t}$		−0.10***		−0.13**	
		[3.62]		[1.98]	
dollar beta$_{i,t}$			0.02		0.01
			[0.22]		[0.10]
carry beta$_{i,t}$ $\times$ Δ FFR$_{t-1}$		0.11**		0.07	
		[2.25]		[0.78]	
dollar beta$_{i,t}$ $\times$ Δ FFR$_{t-1}$			−0.01		0.03
			[0.02]		[0.08]
Overall R^2 in %	5.43	7.30	5.44	43.95	43.31
Avg. #Time periods	293	293	293	293	293
#Currencies	9	9	9	9	9
Currency FE	yes	yes	yes	yes	yes
Time series FE	no	no	no	yes	yes

Note: This table reports results from monthly fixed effects panel regressions of the form $\Delta y_{i,t} = \mu_i + \alpha_t + \beta \Delta FFR_{t-1} + \gamma X_{i,t} + \varphi(X_{i,t} \times \Delta FFR_{t-1}) + \epsilon_{i,t}$, where the dependent variable is the change in the policy rate by foreign central bank i one period ahead and ΔFFR_t is the change in the Federal funds target rate. We include both country- and time-fixed effects μ_i and α_t, respectively. $X_{\mathrm{i,t}}$ denotes either the *carry beta*$_{\mathrm{i,t}}$ or *dollar beta*$_{\mathrm{i,t}}$ that are based on rolling window regressions of currency excess returns on the carry and dollar factor, respectively. Both dependent and independent variables are measured in units of standard deviations. The test statistics based on double clustered (by currencies and time) standard errors, allowing for serial correlation up to 3 lags are reported in brackets. Asterisks *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. The sample spans from January 2000 to March 2024.

Our results remain qualitatively similar when we control for foreign central banks' announcement surprises following Shah (2022). We report these results in the Online

Appendix Table C.10.

F. Alternative Measures of Monetary Policy Shocks

For robustness, we consider alternative measures of monetary policy shocks. Our main analysis has employed high-frequency changes in Federal Fund futures prices around FOMC announcements (Kuttner, 2001; Bernanke and Kuttner, 2005). These shocks primarily capture the surprise in the policy target rate. There is a large literature on measuring different components of monetary policy surprises and we consider some recent contributions. Kearns et al. (2022) build on the work by Swanson (2021) but take a simpler approach and construct target rate, path, and long-rate surprises.[11] Jarociński and Karadi (2020) decompose monetary policy surprises into monetary policy (MP) and central bank information (CBI) shocks using the high frequency co-movement between interest rates and stock prices. Bauer and Swanson (2023b) follow Nakamura and Steinsson (2018) (NS) and extract monetary policy surprises from changes in Eurodollar futures contracts at different horizons around FOMC meetings. In addition, they also construct a shock series (ORT) that is orthogonal to macroeconomic and financial data that predates the monetary policy announcement and thereby accounts for the "Fed response to news" channel in Bauer and Swanson (2023a). We evaluate these other monetary shocks to confirm the robustness of our findings.

Tables 12 and 13 replicate our results in Tables 5 and 6 but using various measures of monetary policy shocks. The evidence can be summarized along two dimensions: First, focusing on the interaction effects with carry and dollar betas we find that only the target factor shocks by Kearns et al. (2022), Jarociński and Karadi (2020), and Bauer and Swanson (2023b) deliver consistent results with our baseline estimates in the first column. Second, path and long-rate (Kearns et al., 2022) shocks as well as central bank information shocks (Jarociński and Karadi, 2020) are not associated with any significant foreign currency flows or syndicated loans.

G. European Monetary Policy Shocks

The evidence so far has focused on US monetary policy shocks and US dollar-based currency pairs. A natural question to ask is whether other central banks' monetary policy shocks matter for dollar-based currency flows and whether euro-based currency pairs respond similarly to monetary shocks originating from the European Central Bank (ECB).

We find no evidence for either of these two hypotheses. In particular, we replace US monetary policy shocks with ECB monetary policy shocks from Jarociński and Karadi

[11] We are sincerely grateful to Andreas Schrimpf for providing access to several of these shock series.

Table 12. Currency Flows of Funds in Response to Alternative Monetary Policy Shocks

	Kuttner (2001)	Kearns et al. (2022)			Jarociński and Karadi (2020)		Bauer and Swanson (2023b)	
		Target	Path	Long-rate	MP	CBI	NS	ORT
carry $\text{beta}_{i,t}$	0.00	0.01	0.01	0.01	0.00	0.01	0.02	0.01
	[0.08]	[0.17]	[0.24]	[0.19]	[0.05]	[0.20]	[0.37]	[0.22]
dollar $\text{beta}_{i,t}$	0.12	0.10	0.10	0.11	0.11	0.11	0.11	0.10
	[0.65]	[0.60]	[0.61]	[0.64]	[0.66]	[0.65]	[0.65]	[0.61]
MPS_t	0.24**	−0.02	0.05*	−0.03	0.04	−0.01	0.03*	0.02
	[2.45]	[0.82]	[1.80]	[0.85]	[1.15]	[1.01]	[1.85]	[0.77]
carry $\text{beta}_{i,t} \times \text{MPS}_t$	0.14***	0.08**	−0.03*	−0.02	0.01	0.02	0.05	0.01**
	[3.79]	[2.29]	[1.77]	[0.58]	[0.64]	[0.59]	[1.34]	[2.46]
dollar $\text{beta}_{i,t} \times \text{MPS}_t$	−0.26***	0.03***	0.05	0.04	0.03	0.04	0.02	0.03
	[2.67]	[4.38]	[1.42]	[1.02]	[1.16]	[1.15]	[0.49]	[1.33]
Δ log bid-ask $\text{spread}_{i,t}$	−0.01	−0.03	−0.03	−0.03	−0.04	−0.03	−0.04*	−0.03
	[0.59]	[1.42]	[1.52]	[1.57]	[1.54]	[1.38]	[1.72]	[1.47]
$\Delta \log S_{i,t}$	−0.01	−0.01	−0.02	−0.02	−0.02	−0.02	−0.02	−0.01
	[0.39]	[0.41]	[0.55]	[0.64]	[0.55]	[0.66]	[0.50]	[0.47]
Overall R^2 in %	20.08	20.62	20.36	20.21	20.27	20.12	20.61	20.51
Avg. #Time periods	138	137	137	137	137	137	136	129
#Currencies	9	9	9	9	9	9	9	9
Currency FE	yes	yes	yes	yes	yes	yes	yes	yes

Note: This table reports results from panel regressions of the form $OF(S_{i,t}) = \mu_i + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \epsilon_{i,t}$, where $OF(S_{i,t})$ is the order flow by *funds* in \$bn in currency pair i in month t. $X_{\text{i,t}}$ denotes either the *carry beta*$_{\text{i,t}}$ or *dollar beta*$_{\text{i,t}}$ that are based on rolling window regressions of currency excess returns on the carry and dollar factor, respectively. MPS_t is a monetary policy shock shown in the column headers. Both dependent and independent variables are measured in units of standard deviations. The test statistics based on double clustered (by currencies and time) standard errors, allowing for serial correlation up to 3 lags are reported in brackets. Asterisks *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. The sample spans from September 2012 to March 2024.

(2020) and find that global currency flows are largely unresponsive to changes in European monetary policy. We interpret this as evidence that US monetary policy is leading the global financial cycle as shown in Brusa, Savor, and Wilson (2019) and Miranda-Agrippino and Rey (2020).

In Table 14 we replicate the results of Table 4 but replace dollar-based currency pairs with euro-based (e.g., EURCAD) ones and employ ECB monetary policy shocks from Jarociński and Karadi (2020) instead of US shocks based on Kuttner (2001). Note that our sample period is shorter due to the availability of the ECB monetary policy shock series. In brief, euro-based currency pairs do not seem to respond to ECB monetary policy shocks.

VII. Conclusion

The transmission of monetary policy is a central question in economics and finance. A central bank's decisions are often made for the benefit of their own domestic economy, but countless studies have documented the spillover effects of central banks housed in large

Table 13. Foreign Currency Loans in Response to Alternative Monetary Policy Shocks

	Kuttner (2001)	Kearns et al. (2022)			Jarociński and Karadi (2020)		Bauer and Swanson (2023b)	
		Target	Path	Long-rate	MP	CBI	NS	ORT
carry $\text{beta}_{\text{i,t}}$	−0.37	−0.32	−0.33	−0.29	−0.37	−0.40	−0.36	−0.34
	[1.19]	[1.09]	[1.10]	[0.98]	[1.20]	[1.29]	[1.14]	[1.16]
dollar $\text{beta}_{\text{i,t}}$	0.46	0.23	0.23	0.22	0.46	0.47	0.46	0.51
	[1.07]	[1.05]	[0.99]	[0.90]	[1.11]	[1.14]	[1.12]	[1.26]
MPS_{t}	0.49**	0.18	−0.22	−0.10	0.23	0.25	0.33	−0.32
	[2.04]	[0.66]	[0.42]	[0.16]	[1.03]	[1.07]	[0.87]	[0.65]
carry $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$	0.13**	0.09	0.22*	−0.22*	0.23**	−0.10	0.11	0.30***
	[2.48]	[1.17]	[1.73]	[1.76]	[2.31]	[0.77]	[1.14]	[2.77]
dollar $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$	−0.46*	−0.03	0.21	0.07	−0.25	−0.49*	−0.46	0.34
	[1.87]	[0.07]	[0.39]	[0.12]	[0.74]	[1.67]	[1.05]	[0.67]
$\Delta \log S_{i,t}$	−0.09	0.05	0.02	0.02	−0.11	−0.14	−0.10	−0.17
	[0.79]	[0.35]	[0.17]	[0.13]	[0.87]	[1.11]	[0.82]	[1.22]
Overall R^2 in %	58.12	57.75	57.77	57.93	58.18	58.22	58.14	58.22
Avg. #Time periods	291	257	257	261	290	290	288	281
#Currencies	9	9	9	9	9	9	9	9
Currency FE	yes	yes	yes	yes	yes	yes	yes	yes

Note: This table reports results from fixed effects panel regressions of the form $\log Loan_{i,t} = \mu_i + \alpha_t + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \gamma\Delta \log S_{i,t} + \epsilon_{i,t}$, where $\log Loan_{i,t}$ is the natural log of the dollar amount lent by global banks headquartered in the US to corporations domiciled abroad in currency i during month t. $X_{\text{i,t}}$ denotes either the *carry* $\textit{beta}_{\text{i,t}}$ or *dollar* $\textit{beta}_{\text{i,t}}$ that are based on rolling window regressions of currency excess returns on the carry and dollar factor, respectively. MPS_t is a monetary policy shock shown in the column headers. $\Delta s_{i,t}$ is the log change in the spot exchange rate expressed as the number of foreign currency units per unit of US dollar. The independent variables are measured in units of standard deviations. The test statistics based on double clustered (by currencies and time) standard errors, allowing for first-order serial correlation are reported in brackets. Asterisks *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. The sample spans from January 2000 to March 2024.

and developed markets having a material and disproportionate impact on the fortunes of other economies.

We study if the currency factor structure can provide a lens through which we can understand this international transmission and provide evidence in favor of this idea. First, we show that investment funds direct flows from low-risk to high-risk currencies in response to an unexpected easing of US monetary policy. Second, global US banks tilt their foreign currency lending toward currencies that are more exposed to systematic currency risk. Both facts are consistent with the risk-taking channel of monetary policy and not an explanation based on reaching for yield. Third, these currency flows and syndicated bank loans persist for several months. We track bank loans to firms' borrowing and investment, and therefore the real effects of monetary policy. These real effects are more pronounced in countries that have currencies, facing markedly different exposures to systematic currency risk.

To the best of our knowledge, we are the first to show that US monetary policy is transmitted internationally through measures of systematic currency risk. Rather than

Table 14. Flow Betas for Euro Currency Pairs

	Corporates	**Funds**	**NBFIs**	**Non-dealer banks**	**Dealer banks**	carry beta	euro beta
EURCHF	−0.22***	−0.12	−0.17*	−0.07	0.19*	−0.17	0.64
	[4.14]	[0.78]	[1.89]	[1.09]	[1.78]		
EURJPY	0.08	0.18	0.05	−0.22*	0.11*	−0.02	1.18
	[1.09]	[1.34]	[1.06]	[1.86]	[1.69]		
EURDKK	0.04	0.06	0.14	−0.16***	0.09*	0.00	0.01
	[0.23]	[0.89]	[1.52]	[2.79]	[1.81]		
EURGBP	−0.09	0.12	−0.07	−0.15*	0.11	0.11	0.99
	[1.01]	[1.63]	[0.85]	[1.84]	[1.38]		
EURSEK	−0.03	−0.07	0.01	0.12	−0.06	0.16	0.59
	[0.42]	[0.98]	[0.07]	[1.19]	[0.66]		
EURUSD	−0.10	−0.15	0.09	−0.04	0.16*	0.19	1.23
	[0.90]	[1.30]	[1.20]	[0.74]	[1.79]		
EURNOK	0.06	−0.07	0.04	0.03	0.02	0.34	1.14
	[0.71]	[1.12]	[0.71]	[0.40]	[0.35]		
EURCAD	−0.04	−0.21	0.15**	0.12*	0.02	0.46	1.49
	[0.82]	[0.94]	[2.33]	[1.91]	[0.12]		
EURAUD	0.02	−0.02	−0.12*	0.17	−0.14	0.68	1.74
	[0.23]	[0.21]	[1.93]	[1.37]	[0.93]		

Note: This table reports the β regression coefficients from $OF(S_{ij,t}) = a_{ij} + \beta_{ij} MPS_t + \epsilon_{ij,t}$, where $OF(S_{ij,t})$ is the currency flow in €mn in currency pair i customer group j in month t and MPS_t is our monetary policy shock measure based on Jarociński and Karadi (2020). Both dependent and independent variables are measured in units of standard deviations. Currency pairs are sorted by carry betas in ascending order. The column labelled "Dealer banks" is equal to the sum of the first four columns times minus one. The last two columns report the average carry and euro beta that we compute based on rolling window regressions. For both the carry and euro factor (average exchange rate change against the euro) we are only using the nine euro-currency pairs displayed in the first column. Asterisks *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. The numbers inside the brackets are the corresponding test statistics based on robust standard errors (Newey and West, 1987) correcting for heteroskedasticity and serial correlation up to 3 lags. The sample spans from September 2012 to October 2023.

being narrowly confined to explaining the risk, return, and co-movement of currencies, our evidence supports the view that the exchange rate factor structure can be used as a lens through which we can study the international transmission of US monetary policy.

We hope our findings spur work into similar ideas concerning other macroeconomic phenomena that can be simply and better understood through risk exposures that have been studied so extensively in the asset pricing literature.

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Appendix A. Theoretical Appendix

An intermediary, which could be a fund or a bank, solves an allocation problem for N different currencies. They make a choice, $\mathbf{d}$, which could have both positive and negative elements, given the properties of the currency excess returns $\mathbf{R}^e$. Both $\mathbf{d}$ and $\mathbf{R}^e$ are N-vectors. We assume excess returns are normally distributed with mean $\mathbb{E}[\mathbf{R}^e]$ and covariance matrix Σ and intermediary preferences display CARA, following Itskhoki and Mukhin (2021). The problem is

$$\max_{\mathbf{d}} \mathbb{E}\left[-\frac{1}{\gamma}\exp\{-\gamma \mathbf{d}'\mathbf{R}^e\}\right] \tag{A.1}$$

and has the solution

$$\mathbf{d} = \frac{1}{\gamma}\Sigma^{-1}\mathbb{E}[\mathbf{R}^e]. \tag{A.2}$$

The intermediaries trade off risk and return, accounting for the covariance across currencies. Following Verdelhan (2018), we assume the existence of a factor structure in exchange rates; that is, the expected excess return for currency i can be decomposed as $\mathbb{E}[R_i^e] = \beta_i'\lambda$ where λ is the set of *globally priced* risk factors that affect currency returns and β_i summarize currency i's exposure to these factors. These betas are fixed, as are the prices of risk. Lustig et al. (2011) show that average interest rate differentials (with respect to the US) line up with carry factor (HML) exposures β_i^{HML}.

Risk-on in Financial Markets. In accordance with the risk-taking channel of monetary policy, we interpret an unexpected easing as an increase in the risk tolerance of financial intermediaries; that is, the unexpected easing lowers γ.

This could arise as the marginal cost of risk capital, which is typically funded in short-term and often overnight markets, has declined. The optimal response, in equilibrium, would be to raise the amount of capital at risk to the point where its marginal benefit is reduced to equal its lower marginal cost. For a given Σ and $\mathbb{E}[\mathbf{R}^e]$, more capital at risk requires a lower γ.

Thus, the decline in risk aversion caused by an unexpected easing can be interpreted as arising from a downward-sloping demand curve for risk-taking by intermediaries. A similar mechanism operates in Gabaix and Maggiori (2015), in which an intermediary's capital constraint is a function of both exchange rate volatility and its risk aversion.

Numerical example. We download monthly currency data from January 1988 to April 2020 for Australia, Canada, Germany/euro, Japan, New Zealand, Switzerland, and

Great Britain from Adrien Verdelhan's website[12]. The covariance matrix is estimated from spot rate changes over the full sample and average interest rate differentials are calculated over the full sample. Since spot exchange rate changes are near martingales Meese and Rogoff (1983), we proxy for expected excess returns with average interest rate differentials. Below we report the average differential and the covariance matrix, both multiplied by 12×100.

$$\mathbb{E}[\mathbf{R}^e] \times 1,200 = \begin{bmatrix} 2.314 \\ 0.500 \\ -0.464 \\ -2.417 \\ 2.709 \\ -1.616 \\ 1.270 \end{bmatrix} \begin{pmatrix} \text{AUD} \\ \text{CAD} \\ \text{EUR} \\ \text{JPY} \\ \text{NZD} \\ \text{CHF} \\ \text{GBP} \end{pmatrix}$$

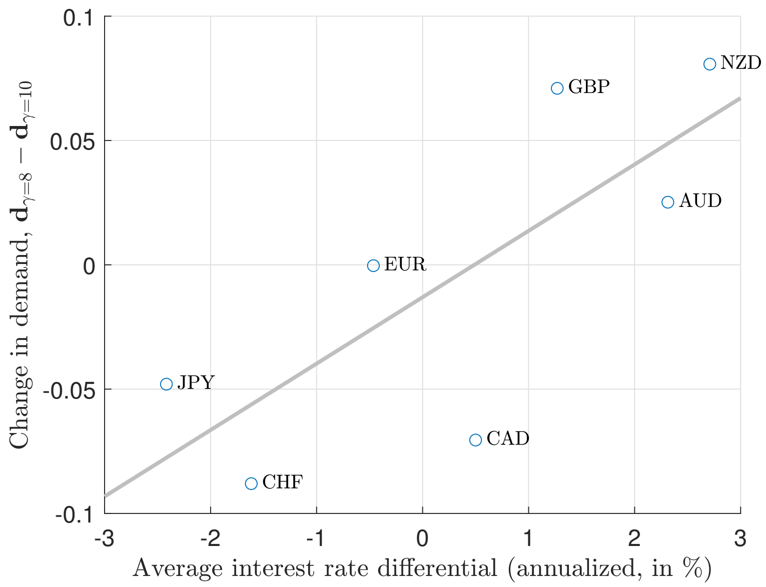
$$\Sigma \times 1,200 = \begin{bmatrix} 1.288 & 0.563 & 0.524 & 0.146 & 1.003 & 0.436 & 0.418 \\ 0.563 & 0.587 & 0.287 & 0.019 & 0.488 & 0.189 & 0.253 \\ 0.524 & 0.287 & 1.015 & 0.389 & 0.621 & 0.924 & 0.642 \\ 0.146 & 0.019 & 0.389 & 1.117 & 0.243 & 0.512 & 0.231 \\ 1.003 & 0.488 & 0.621 & 0.243 & 1.336 & 0.585 & 0.456 \\ 0.436 & 0.189 & 0.924 & 0.512 & 0.585 & 1.157 & 0.584 \\ 0.418 & 0.253 & 0.642 & 0.231 & 0.456 & 0.584 & 0.916 \end{bmatrix}$$

Given these estimates of Σ and $\mathbb{E}[\mathbf{R}^e]$ we solve for $\mathbf{d}_{\gamma=10}$ with $\gamma = 10$. To mimic a "risk-on" in financial markets, we then change γ to 8 and call the solution $\mathbf{d}_{\gamma=8}$. Note that the norm of $\|\mathbf{d}_{\gamma=8}\| > \|\mathbf{d}_{\gamma=10}\|$, indicating the average position is larger, consistent with more capital at risk. In Figure A.1 we plot the change in demand as $\mathbf{d}_{\gamma=8} - \mathbf{d}_{\gamma=10}$ on average interest rate differentials.

Looking at the figure, we see that there are positive demand changes to countries that are risky, like New Zealand and Australia, as exemplified by their high average interest rates. Conversely, countries with low currency risk, like Japan and Switzerland, see negative changes in demand to, or outflows from, their currencies. All told, the unexpected easing produces a "risk-on" pattern that is associated with intermediaries selling out of low-risk currencies and increasing their investments in high-risk currencies.

[12] https://web.mit.edu/adrienv/www/Data_for_AugmentedUIP_allcountries.xls

Figure A.1. Changes in demand following a decline in risk aversion



Note: Data are monthly from January 1988 until April 2020 and downloaded from `https://web.mit.edu/adrienv/www/Data_for_AugmentedUIP_allcountries.xls`
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Online Appendix — Not for Publication

Appendix B. Forward Currency Flows

We analyze currency flows in forward contracts, which contain information about the amount of carry trade positions opened at a given point in time. Forwards differ by maturity, so by observing what maturity currency market participants most heavily trade we can gauge their response to monetary policy shocks. If participants trade longer maturity forwards, it indicates that they expect the foreign currency to experience a longer price appreciation. This ties directly to the expected duration of the impact of monetary policy shocks on exchange rates.

To test our hypothesis, we start by running regressions of forward currency flows on our monetary policy shock measure and by varying the maturity of the forward contracts. As before, we focus on the impact of investment funds as they are the largest directional group of traders:

$$OF(F_{i,t+m}) = \mu_i + \alpha_t + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \kappa \mathbf{W}_{i,t} + \epsilon_{i,t+m}, \quad \text{(B.1)}$$

where $F_{i,t+m}$ is the forward contract associated with currency i that is opened at time t and matures m periods later, $OF(F_{i,t+m})$ is the corresponding forward currency flow, and X_i denotes our currency risk characteristics, that is, dollar and carry betas. In $\mathbf{W}_{i,t}$ we include the log change in the monthly average relative bid-ask spread and the spot exchange rate as controls.

Both the dependent variable and regressors are in standardized units for comparability across maturities. Table B.1 shows the responses for one-month, three-month, and one-year maturities. In line with the evidence for spot transactions, we find that for one-month contracts outflows from the US to foreign countries with positive carry betas pick up following a monetary expansion. Specifically, the interaction term for the carry beta confirms that riskier currencies receive disproportionately larger flows. In terms of economic magnitudes, a one standard deviation increase in the carry beta raises the forward flow by 0.03 of a standard deviation, constituting a substantially smaller economic effect compared to what we found for the spot market.

When looking at longer horizons, we see that the interaction coefficients for carry betas become insignificant at the three-month horizon before turning negative one year out. Thus, at the 12-month horizon, the carry trade positions begin to unwind as funds reduce their exposure to foreign currencies. Contrarily, the interaction effects for dollar betas are insignificant at the one- and three-month horizon but are highly significant at the 12-month mark. Overall, these results are consistent with monetary policy shocks having an economic effect on forward flows that lasts for at least one month, but is not expected to last beyond twelve.

We interpret the results in this section in light of the evidence presented in Lustig et al. (2019), who find that carry trade returns are generally most pronounced at short maturities and typically decline with maturity. Of course, our results are not conclusive on how investment funds implement the carry trade as forward contracts are but one method to do so. Alternatively, funds can buy some foreign currency in the spot market (see Section III.A) and use the proceeds to buy foreign government securities. That said, our results do indicate that funds prefer short-term forwards to take on currency risk and that they take on larger positions in riskier currencies.

Table B.1. Forward Currency Flows of Funds and the FX Factor Structure

	1M		**3M**		**12M**	
	(1)	(2)	(3)	(4)	(5)	(6)
carry beta$_{\mathrm{i,t}}$	0.01		−0.06		−0.11	
	[0.04]		[0.78]		[1.44]	
dollar beta$_{\mathrm{i,t}}$		−0.22		−0.19*		−0.08
		[1.15]		[1.87]		[0.72]
carry beta$_{\mathrm{i,t}}$ × MPS$_{\mathrm{t}}$	0.03*		0.00		−0.07***	
	[1.94]		[0.34]		[5.01]	
dollar beta$_{\mathrm{i,t}}$ × MPS$_{\mathrm{t}}$		0.10*		0.02		−0.15***
		[1.75]		[0.38]		[6.25]
Δ log bid-ask spread$_{\mathrm{i,t}}$	0.01	0.00	0.01	0.01	−0.01	0.01
	[0.20]	[0.06]	[0.71]	[0.59]	[0.25]	[0.17]
$\Delta \log S_{i,t}$	−0.03	−0.04	−0.02	−0.02	−0.02	−0.02
	[1.43]	[1.58]	[0.76]	[0.91]	[0.95]	[0.64]
Overall R^2 in %	61.08	62.20	62.82	63.58	32.39	32.11
Avg. #Time periods	138	138	138	138	138	138
#Currencies	9	9	9	9	9	9
Currency FE	yes	yes	yes	yes	yes	yes
Time series FE	yes	yes	yes	yes	yes	yes

Note: This table reports results from fixed effects panel regressions of the form $OF(F_{i,t+m}) = \mu_i + \alpha_t + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \kappa \mathbf{W}_{i,t} + \epsilon_{i,t+m}$, where $OF(F_{i,t+m})$ is the $m = 1, 3$ or 12 months forward flow by *funds* measured in \$bn in currency pair i in month t. $X_{\mathrm{i,t}}$ denotes either the *carry beta*$_{\mathrm{i,t}}$ or *dollar beta*$_{\mathrm{i,t}}$ that are based on rolling window regressions of currency excess returns on the carry and dollar factor, respectively. MPS_t is our monetary policy shock measure in basis points that we extract from Fed Fund futures rate changes following Kuttner (2001). $\mathbf{W}_{i,t}$ may include the following control variables: Δ log *bid-ask spread*$_{\mathrm{i,t}}$ is the log change in the monthly average relative bid-ask spread and $\Delta \log S_{i,t}$ is the log change in the spot exchange rate expressed as the number of foreign currency units per unit of US dollar. Both dependent and independent variables are measured in units of standard deviations. The test statistics based on double clustered (by currencies and time) standard errors, allowing for serial correlation up to 3 lags are reported in brackets. Asterisks *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. The sample spans from September 2012 to March 2024.

Appendix C. Additional Results

Table C.1. Summary Statistics — Systematic Currency Risk Measures

	Carry beta				Dollar beta			
	T1	T2	T3	ACF	T1	T2	T3	ACF
USDAUD	0.00	0.00	100.00	99.56	3.09	25.09	71.82	97.33
USDCAD	0.00	32.99	67.01	99.41	80.41	19.59	0.00	99.10
USDCHF	85.91	14.09	0.00	99.33	43.30	37.80	18.90	98.35
USDEUR	68.04	31.96	0.00	99.83	1.72	65.98	32.30	98.70
USDGBP	24.05	75.95	0.00	99.71	74.57	25.43	0.00	98.34
USDJPY	85.91	14.09	0.00	98.32	89.69	6.19	4.12	99.12
USDNOK	18.56	63.92	17.53	99.49	6.53	51.89	41.58	98.86
USDNZD	0.00	0.00	100.00	99.50	0.00	24.40	75.60	97.67
USDSEK	17.53	67.01	15.46	99.82	0.69	43.64	55.67	98.72

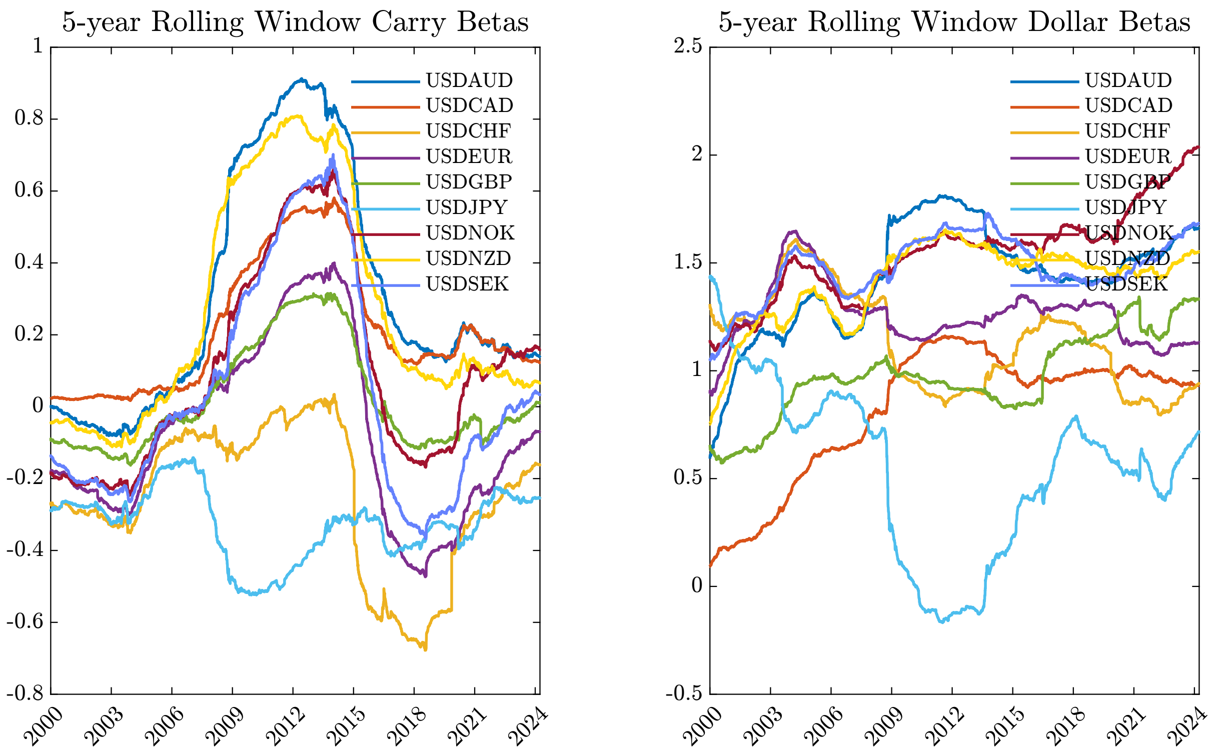
Note: This table reports various summary statistics of the systematic currency risk measures shown in the table headers. The columns labelled $T1$, $T2$, $T3$ show the relative frequency of a given currency pair being assigned to each of the three portfolio tertiles (i.e., $T1$, $T2$, $T3$). Reading example: around 84.19% of the time USDJPY is part of the first tertile $T1$ (low-risk-currencies) when sorting based on carry betas. The columns labelled ACF show the first-order autocorrelation coefficient of the risk measures themselves. A higher reading corresponds to higher levels of time-series persistence. The sample covers the period from January 2000 to March 2024.

Table C.2. Monetary Policy Shocks and Systematic Currency Risk — Monthly

Dep. variable: dollar betas	USDAUD	USDCAD	USDCHF	USDEUR	USDGBP	USDJPY	USDNOK	USDNZD	USDSEK
Intercept (α)	0.060	0.044	−0.032	−0.010	0.070	−0.053	0.072	0.053	0.085
	[0.966]	[0.811]	[0.638]	[0.192]	[1.445]	[0.745]	[1.188]	[0.811]	[1.324]
MPStextsubscriptt	−0.099	−0.131	0.230*	0.238	0.039	0.156	−0.081	−0.017	0.158*
	[0.990]	[1.417]	[1.656]	[1.400]	[0.511]	[1.537]	[0.810]	[0.208]	[1.716]
$\bar{R}^2$ in %	0.64	1.39	4.98	5.36	−0.19	2.10	0.31	−0.32	2.15
#Obs	290	290	290	290	290	290	290	290	290
Dep. variable: carry betas	USDAUD	USDCAD	USDCHF	USDEUR	USDGBP	USDJPY	USDNOK	USDNZD	USDSEK
Intercept (α)	0.002	0.006	0.026	0.012	0.017	0.050	0.026	0.021	0.007
	[0.029]	[0.102]	[0.398]	[0.147]	[0.225]	[0.700]	[0.395]	[0.304]	[0.091]
MPStextsubscriptt	−0.166	−0.190	−0.099	−0.153*	−0.194*	0.012	−0.231	−0.153**	−0.155
	[1.518]	[1.564]	[1.629]	[1.923]	[1.839]	[0.385]	[1.385]	[2.355]	[1.629]
$\bar{R}^2$ in %	2.43	3.28	0.64	2.02	3.46	−0.33	5.03	2.00	2.08
#Obs	290	290	290	290	290	290	290	290	290

Note: This table reports results from *monthly* regressions of the form $\Delta y_{i,t} = \mu_i + \beta MPS_t + \epsilon_{i,t}$, where the dependent variable is the first-difference in either the dollar or the carry beta, respectively. MPS_t is our monetary policy shock in basis points that we extract from Fed Fund futures rate changes following Kuttner (2001). Both dependent and independent variables are measured in units of standard deviations. The numbers inside the brackets are the corresponding test statistics based on robust standard errors (Newey and West, 1987) correcting for heteroskedasticity and serial correlation. Asterisks *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. The sample covers the period from January 2000 to March 2024.

Figure C.1. Carry and Dollar Betas



Note: This figure plots carry and dollar betas across G10 currency pairs that are based on 60-month rolling window regressions of currency excess returns on the carry and dollar factor, respectively. The sample is monthly and covers the period from January 2000 to March 2024.

Table C.3. Summary Statistics — CLS Forward Flows

		USDAUD			USDCAD			USDCHF			USDEUR			USDGBP		
		1M	3M	12M	1M	3M	12M	1M	3M	12M	1M	3M	12M	1M	3M	12M
Corporates	Std.	0.52	0.45	0.42	0.80	0.73	0.70	0.57	0.57	0.57	4.78	3.81	3.49	1.99	1.41	1.23
	Share	0.26	0.36	0.36	0.19	0.28	0.29	1.01	0.96	0.91	1.99	2.25	2.19	0.73	1.03	0.99
Funds	Std.	3.55	3.03	2.63	15.90	15.55	15.50	4.98	3.11	2.46	16.72	13.26	11.46	12.08	6.37	5.89
	Share	3.62	6.11	10.56	7.40	8.44	10.19	1.04	6.09	8.72	5.53	9.48	13.48	3.47	7.63	12.51
NBFIs	Std.	0.49	0.46	0.46	1.02	1.03	1.03	1.48	1.45	1.46	1.51	1.54	1.46	1.78	1.56	1.56
	Share	3.59	3.40	3.20	2.08	2.03	1.99	4.90	4.42	4.22	3.51	3.30	3.21	4.22	3.82	3.61
Banks	Std.	4.54	4.18	4.02	31.49	31.31	31.40	5.13	4.71	4.24	17.32	15.43	14.70	10.21	8.24	8.06
	Share	92.54	90.12	85.87	90.34	89.25	87.53	93.06	88.53	86.15	88.97	84.97	81.12	91.58	87.52	82.89

		USDILS			USDJPY			USDNOK			USDNZD			USDSEK		
		1M	3M	12M	1M	3M	12M	1M	3M	12M	1M	3M	12M	1M	3M	12M
Corporates	Std.	0.03	0.03	0.03	1.27	0.96	0.94	0.12	0.12	0.12	0.06	0.04	0.04	0.19	0.18	0.18
	Share	0.14	0.14	0.14	0.76	0.89	0.86	0.51	0.45	0.40	0.03	0.08	0.08	1.35	1.31	1.19
Funds	Std.	0.21	0.28	0.15	5.45	5.17	4.85	0.76	0.69	0.58	1.78	1.26	1.18	1.11	1.05	0.98
	Share	1.57	1.63	3.52	5.01	6.33	8.72	4.55	6.51	12.58	0.03	3.61	7.15	13.11	15.57	20.56
NBFIs	Std.	0.08	0.07	0.07	1.02	0.98	0.96	0.10	0.10	0.10	0.15	0.15	0.15	0.12	0.12	0.12
	Share	0.86	0.85	0.83	3.38	3.27	3.17	3.66	3.26	2.98	3.94	3.72	3.48	3.45	2.95	2.82
Banks	Std.	1.46	1.38	1.42	7.55	7.12	6.54	1.74	1.59	1.57	1.81	1.78	1.69	1.93	1.71	1.63
	Share	97.43	97.38	95.52	90.85	89.51	87.25	91.29	89.78	84.04	96.00	92.59	89.29	82.08	80.18	75.43

Note: This table collects simple summary statistics for the CLS forward order flow data across three maturities: 1-month (*1M*), 3-month (*3M*), and 1-year (*12M*). The columns labelled *Std.* report the standard deviation of monthly order flows (buy volume minus sell volume) in $bn broken down by four categories of market participants, namely, corporates, funds, non-bank financials (NBFIs), and non-dealer banks (Banks). The rows labelled *Share* are computed based on the sum of buy and sell volume and reflect the relative share (summing up to 100% for each currency pair) in percent of trading volume associated with each of the four groups of market participants. The sample covers the period from September 2012 to March 2024.

Table C.4. Currency Flows of Funds and the FX Factor Structure — Ranking

	(1)	(2)	(3)	(4)	(5)	(6)
carry beta $\text{rank}_{\text{i,t}}$		0.06		0.05		0.05
		[0.48]		[0.51]		[0.50]
dollar beta $\text{rank}_{\text{i,t}}$			0.03		0.03	0.02
			[0.25]		[0.32]	[0.18]
MPS_{t}	0.03	−0.14**	−0.01			
	[0.86]	[2.08]	[0.24]			
carry beta $\text{rank}_{\text{i,t}} \times \text{MPS}_{\text{t}}$		0.20***		0.20***		0.34***
		[2.71]		[2.61]		[4.20]
dollar beta $\text{rank}_{\text{i,t}} \times \text{MPS}_{\text{t}}$			0.06		0.05	−0.20***
			[1.22]		[1.01]	[3.00]
$\Delta \log$ bid-ask $\text{spread}_{\text{i,t}}$		−0.03	−0.03	−0.01	−0.02	0.02
		[1.36]	[1.59]	[0.74]	[0.90]	[0.86]
$\Delta \log S_{i,t}$		−0.01	−0.02	−0.02	−0.03	−0.02
		[0.35]	[0.52]	[0.38]	[0.67]	[0.45]
Overall R^2 in %	18.76	19.72	18.89	31.05	30.22	31.44
Avg. #Time periods	139	138	138	138	138	138
#Currencies	9	9	9	9	9	9
Currency FE	yes	yes	yes	yes	yes	yes
Time series FE	no	no	no	yes	yes	yes

Note: This table reports results from fixed effects panel regressions of the form $OF(S_{i,t}) = \mu_i + \alpha_t + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \kappa \mathbf{W}_{i,t} + \epsilon_{i,t}$, where $OF(S_{i,t})$ is the order flow by *funds* in \$bn in currency pair i in month t. $X_{\text{i,t}}$ denotes either the *carry beta rank*$_{\text{i,t}}$ or *dollar beta rank*$_{\text{i,t}}$ that reflect the cross-sectional ranking of carry and dollar betas, respectively. MPS_t is our monetary policy shock in basis points that we extract from Fed Fund futures rate changes following Kuttner (2001). $\mathbf{W}_{i,t}$ may include the following control variables: $\Delta \log$ *bid-ask spread*$_{\text{i,t}}$ is the log change in the monthly average relative bid-ask spread and $\Delta \log S_{i,t}$ is the log change in the spot exchange rate expressed as the number of foreign currency units per unit of US dollar. Both dependent and independent variables are measured in units of standard deviations. The test statistics based on double clustered (by currencies and time) standard errors, allowing for serial correlation up to 3 lags are reported in brackets. Asterisks *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. The sample covers the period from September 2012 to March 2024.

Table C.5. Currency Flows of Funds and the FX Factor Structure — Scheduled FOMC

	(1)	(2)	(3)	(4)	(5)	(6)
carry $\text{beta}_{\text{i,t}}$		0.02		0.00		−0.15
		[0.36]		[0.02]		[1.00]
dollar $\text{beta}_{\text{i,t}}$			0.13		0.14	0.21
			[0.71]		[0.77]	[0.99]
MPS_{t}	0.02***	0.01	0.05**			
	[5.51]	[0.92]	[2.21]			
carry $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$		0.02**		0.02***		0.07*
		[2.46]		[6.46]		[1.79]
dollar $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$			−0.04**		−0.04*	−0.18*
			[2.48]		[1.75]	[1.81]
Δ log bid-ask $\text{spread}_{\text{i,t}}$		−0.02	−0.02	−0.01	−0.02	−0.01
		[1.34]	[1.47]	[0.66]	[0.69]	[0.65]
$\Delta \log S_{i,t}$		−0.02	−0.02	−0.04	−0.04	−0.04
		[0.47]	[0.47]	[0.69]	[0.64]	[0.66]
Overall R^2 in %	18.73	18.77	19.14	30.18	30.62	30.99
Avg. #Time periods	139	138	138	138	138	138
#Currencies	9	9	9	9	9	9
Currency FE	yes	yes	yes	yes	yes	yes
Time series FE	no	no	no	yes	yes	yes

Note: This table reports results from fixed effects panel regressions of the form $OF(S_{i,t}) = \mu_i + \alpha_t + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \kappa \mathbf{W}_{i,t} + \epsilon_{i,t}$, where $OF(S_{i,t})$ is the order flow by *funds* in \$bn in currency pair i in month t. $X_{\text{i,t}}$ denotes either the *carry* $\textit{beta}_{\text{i,t}}$ or *dollar* $\textit{beta}_{\text{i,t}}$ that are based on rolling window regressions of currency excess returns on the carry and dollar factor, respectively. MPS_t is our monetary policy shock in basis points that we extract from Fed Fund futures rate changes around *scheduled* FOMC announcements following Kuttner (2001). $\mathbf{W}_{i,t}$ may include the following control variables: Δ log *bid-ask* $\textit{spread}_{\text{i,t}}$ is the log change in the monthly average relative bid-ask spread and $\Delta \log S_{i,t}$ is the log change in the spot exchange rate expressed as the number of foreign currency units per unit of US dollar. Both dependent and independent variables are measured in units of standard deviations. The test statistics based on double clustered (by currencies and time) standard errors, allowing for serial correlation up to 3 lags are reported in brackets. Asterisks *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. The sample covers the period from September 2012 to March 2024.

Table C.6. Weekly Currency Flows of Funds and the FX Factor Structure

	(1)	(2)	(3)	(4)	(5)	(6)
carry $\text{beta}_{\text{i,t}}$		0.02		0.04		0.00
		[0.91]		[0.32]		[0.03]
dollar $\text{beta}_{\text{i,t}}$			−0.01		0.08	0.08
			[0.05]		[0.46]	[0.46]
MPS_{t}	0.03	0.02	0.04			
	[1.55]	[1.47]	[0.49]			
carry $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$		0.03**		0.04**		0.08***
		[2.12]		[2.38]		[3.79]
dollar $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$			−0.01		−0.01	−0.17***
			[0.22]		[0.22]	[2.72]
Δ log bid-ask $\text{spread}_{\text{i,t}}$		0.00	0.00	−0.02**	−0.02**	−0.02**
		[0.04]	[0.03]	[2.28]	[2.41]	[2.30]
$\Delta \log S_{i,t}$		−0.06*	−0.06**	−0.07**	−0.07**	−0.07**
		[1.95]	[1.97]	[2.25]	[2.26]	[2.33]
Overall R^2 in %	8.32	8.79	8.66	21.01	20.92	21.19
Avg. #Time periods	605	604	604	604	604	604
#Currencies	9	9	9	9	9	9
Currency FE	yes	yes	yes	yes	yes	yes
Time series FE	no	no	no	yes	yes	yes

Note: This table reports results from fixed effects panel regressions of the form $OF(S_{i,t}) = \mu_i + \alpha_t + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \kappa \mathbf{W}_{i,t} + \epsilon_{i,t}$, where $OF(S_{i,t})$ is the order flow by *funds* in \$bn in currency pair i in calendar week t. $X_{\text{i,t}}$ denotes either the *carry* $\textit{beta}_{\text{i,t}}$ or *dollar* $\textit{beta}_{\text{i,t}}$ that are based on rolling window regressions of currency excess returns on the carry and dollar factor, respectively. MPS_t is our monetary policy shock in basis points that we extract from Fed Fund futures rate changes following Kuttner (2001). $\mathbf{W}_{i,t}$ may include the following control variables: Δ log *bid-ask* $\textit{spread}_{\text{i,t}}$ is the log change in the monthly average relative bid-ask spread and $\Delta \log S_{i,t}$ is the log change in the spot exchange rate expressed as the number of foreign currency units per unit of US dollar. Both dependent and independent variables are measured in units of standard deviations. The test statistics based on double clustered (by currencies and time) standard errors, allowing for serial correlation up to 3 lags are reported in brackets. Asterisks *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. The sample covers the period from September 2012 to March 2024.

Table C.7. Currency Flows of Funds and the FX Factor Structure — G10 + EMs

	(1)	(2)	(3)	(4)	(5)	(6)
carry $\text{beta}_{\text{i,t}}$		0.02		0.05		−0.12
		[0.34]		[0.27]		[0.80]
dollar $\text{beta}_{\text{i,t}}$			0.06		0.15	0.19
			[0.45]		[0.94]	[1.11]
MPS_{t}	0.02	0.01	0.01			
	[0.79]	[0.28]	[0.11]			
carry $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$		0.04		0.04		0.15**
		[1.57]		[1.40]		[2.28]
dollar $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$			0.02		0.01	−0.31***
			[0.35]		[0.11]	[2.87]
Δ log bid-ask $\text{spread}_{\text{i,t}}$		−0.03	−0.03	−0.02	−0.01	0.01
		[1.40]	[1.59]	[0.96]	[0.80]	[1.55]
$\Delta \log S_{i,t}$		−0.02	−0.02	−0.04	−0.04	−0.05
		[0.83]	[0.73]	[0.95]	[0.89]	[1.04]
Overall R^2 in %	20.23	20.42	20.38	29.78	30.18	30.63
Avg. #Time periods	139	138	138	138	138	138
#Currencies	12	12	12	12	12	12
Currency FE	yes	yes	yes	yes	yes	yes
Time series FE	no	no	no	yes	yes	yes

Note: This table reports results from fixed effects panel regressions of the form $OF(S_{i,t}) = \mu_i + \alpha_t + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \kappa \mathbf{W}_{i,t} + \epsilon_{i,t}$, where $OF(S_{i,t})$ is the order flow by *funds* in \$bn in currency pair i in month t. $X_{\text{i,t}}$ denotes either the *carry beta*$_{\text{i,t}}$ or *dollar beta*$_{\text{i,t}}$ that are based on rolling window regressions of currency excess returns on the carry and dollar factor, respectively. MPS_t is our monetary policy shock in basis points that we extract from Fed Fund futures rate changes following Kuttner (2001). $\mathbf{W}_{i,t}$ may include the following control variables: Δ log *bid-ask spread*$_{\text{i,t}}$ is the log change in the monthly average relative bid-ask spread and $\Delta \log S_{i,t}$ is the log change in the spot exchange rate expressed as the number of foreign currency units per unit of US dollar. Both dependent and independent variables are measured in units of standard deviations. The test statistics based on double clustered (by currencies and time) standard errors, allowing for serial correlation up to 3 lags are reported in brackets. Asterisks *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. The sample covers the period from September 2012 to March 2024.

Table C.8. Summary Statistics — DealScan

Currency	#Obs	Mean	Std.	5%	25%	50%	75%	95%
AUD	272	500.5	607.0	29.5	127.7	275.8	660.6	1,518.8
CAD	285	938.3	914.3	110.3	313.0	639.1	1,255.5	2,518.2
CHF	70	265.5	462.7	12.1	38.0	117.2	248.2	1,390.8
EUR	291	6,036.1	5,434.1	1,137.6	2,654.6	4,827.0	7,637.6	15,057.9
GBP	277	2,028.6	2,000.4	164.0	688.0	1,531.8	2,553.8	5,684.4
JPY	175	359.7	461.7	5.9	71.3	196.2	466.4	1,483.1
NOK	39	203.4	440.4	14.4	37.6	61.5	160.5	1,155.1
NZD	84	94.0	128.1	8.5	23.9	55.5	112.3	337.3
SEK	72	270.1	527.2	7.5	52.1	146.7	307.7	766.0

Note: This table reports the average *Mean*, standard deviation *Std.*, and the 5, 25, 50, 75 and 95 percentile of the total aggregate loan amount intermediated by global US banks in a given currency (first column). The second column indicates how many months have non-zero loan amounts. All numbers are in $mn, except for the number of observations *#Obs* in the second column. An observation corresponds to the portion of syndicated loan that can be attributed to borrowing from US banks in a given currency aggregated over a month. The sample covers the period from January 2000 to March 2024.

Table C.9. Summary Statistics — DealScan by Currency and Country

	AUD	CAD	CHF	EUR	GBP	JPY	NOK	NZD	SEK	Total
United Arab Emirates				25	4					29
Australia	1,565	3		41	35	1		33		1,678
Canada	6	2,223		32	18					2,279
Switzerland		2	145	295	15	1				458
Czech Republic				40	2					42
Denmark	1			125	6	1	4			137
Euro Area	10	12	15	7,669	259	13	3		5	7,986
United Kingdom	24	3		834	3,314	1	2	1	4	4,183
Hong Kong	4		1	25	6	2		1		39
Hungary				52	1					53
Indonesia				5		3				8
India				23	1	26				50
Japan	1	12		1	7	448				469
South Korea	1			35		48				84
Kuwait										0
Mexico				17				1		18
Malaysia	2		1	2	4	8				17
Norway				94	3		40		2	139
New Zealand	5			4	13			109		131
Philippines				1		12				13
Poland			4	88						92
Saudi Arabia				1						1
Sweden	5			340	6		3		108	462
Singapore	12			11	7	3				33
Thailand					3	24				27
Turkey				1,143						1,143
Taiwan	2	2		2	1	5				12
South Africa	5			38	25	1		1		70

Note: This table reports the total number of syndicated loans intermediated by global US banks in a given currency (columns) broken down by borrower country (rows). The sample covers the period from January 2000 to March 2024.

Table C.10. International Lending and the FX Factor Structure

	(1)	(2)	(3)	(4)	(5)	(6)
carry $\mathrm{beta_{i,t}}$		−0.03		0.67*		−0.04
		[0.23]		[1.94]		[0.05]
dollar $\mathrm{beta_{i,t}}$			0.86*		0.74*	0.78
			[1.69]		[1.71]	[1.05]
$\mathrm{MPS_{t,US}}$	0.01	0.06	0.50			
	[0.12]	[0.77]	[1.07]			
carry $\mathrm{beta_{i,t}} \times \mathrm{MPS_t}$		0.15***		0.14**		0.17***
		[5.80]		[2.05]		[4.74]
dollar $\mathrm{beta_{i,t}} \times \mathrm{MPS_t}$			−0.49		−0.63	−0.68
			[1.08]		[1.56]	[1.23]
$\Delta \log S_{i,t}$	−0.05	−0.04	−0.06	−0.11	−0.15	−0.12
	[0.28]	[0.21]	[0.31]	[0.63]	[0.72]	[0.62]
$\mathrm{MPS_{i,t}}$	0.14	0.14	0.15	0.06	0.07	0.06
	[0.94]	[0.91]	[1.02]	[0.42]	[0.51]	[0.43]
Overall R^2 in %	59.94	59.97	60.21	65.22	65.33	65.36
Avg. #Time periods	192	192	192	192	192	192
#Currencies	9	9	9	9	9	9
Currency FE	yes	yes	yes	yes	yes	yes
Time series FE	no	no	no	yes	yes	yes

Note: This table reports results from fixed effects panel regressions of the form $\log Loan_{i,t} = \mu_i + \alpha_t + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \gamma \Delta \log S_{i,t} + \epsilon_{i,t}$, where $\log Loan_{i,t}$ is the natural log of the dollar amount lent by global banks headquartered in the US to corporations domiciled abroad in currency i during month t. $X_{\mathrm{i,t}}$ denotes either the *carry* $beta_{\mathrm{i,t}}$ or *dollar* $beta_{\mathrm{i,t}}$ that are based on rolling window regressions of currency excess returns on the carry and dollar factor, respectively. $MPS_{t,US}$ is our US monetary policy shock in basis points that we extract from Fed Fund futures rate changes following Kuttner (2001). $MPS_{i,t}$ is the monetary policy shock associated with a foreign central bank i based on Shah (2022). $\Delta s_{i,t}$ is the log change in the spot exchange rate expressed as the number of foreign currency units per unit of US dollar. The independent variables are measured in units of standard deviations. The test statistics based on double clustered (by currencies and time) standard errors, allowing for first-order serial correlation are reported in brackets. Asterisks *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. The sample spans from January 2000 to December 2016.

Table C.11. International Lending and the FX Factor Structure — Ranking

	(1)	(2)	(3)	(4)	(5)	(6)
carry beta $\text{rank}_{\text{i,t}}$		−0.60		−0.60		−0.67
		[0.97]		[0.89]		[0.93]
dollar beta $\text{rank}_{\text{i,t}}$			0.23		0.24	0.32
			[0.51]		[0.62]	[0.74]
$\text{MPS}_{\text{t,US}}$	0.03	0.05	0.35**			
	[0.52]	[1.26]	[2.48]			
carry beta $\text{rank}_{\text{i,t}} \times \text{MPS}_{\text{t}}$		0.11**		0.12**		0.15***
		[1.96]		[2.21]		[3.03]
dollar beta $\text{rank}_{\text{i,t}} \times \text{MPS}_{\text{t}}$			−0.33*		−0.45*	−0.58*
			[1.65]		[1.84]	[1.88]
$\Delta \log S_{i,t}$	−0.08	−0.07	−0.09	−0.05	−0.08	−0.06
	[0.71]	[0.65]	[0.73]	[0.28]	[0.47]	[0.37]
Overall R^2 in %	57.95	58.04	57.97	63.01	62.95	63.07
Avg. #Time periods	291	291	291	291	291	291
#Currencies	9	9	9	9	9	9
Currency FE	yes	yes	yes	yes	yes	yes
Time series FE	no	no	no	yes	yes	yes

Note: This table reports results from fixed effects panel regressions of the form $\log Loan_{i,t} = \mu_i + \alpha_t + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \gamma\Delta \log S_{i,t} + \epsilon_{i,t}$, where $\log Loan_{i,t}$ is the natural log of the dollar amount lent by global banks headquartered in the US to corporations domiciled abroad in currency i during month t. $X_{\text{i,t}}$ denotes either the *carry beta rank*$_{\text{i,t}}$ or *dollar beta rank*$_{\text{i,t}}$ that reflect the cross-sectional ranking of carry and dollar betas, respectively. MPS_t is our monetary policy shock in basis points that we extract from Fed Fund futures rate changes following Kuttner (2001). $\Delta s_{i,t}$ is the log change in the spot exchange rate expressed as the number of foreign currency units per unit of US dollar. The independent variables are measured in units of standard deviations. The test statistics based on double clustered (by currencies and time) standard errors, allowing for first-order serial correlation are reported in brackets. Asterisks *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. The sample spans from January 2000 to March 2024.

Table C.12. International Lending and the FX Factor Structure — Scheduled FOMC

	(1)	(2)	(3)	(4)	(5)	(6)
carry $\text{beta}_{\text{i,t}}$		−0.33		−0.69		−1.34
		[1.22]		[1.59]		[1.40]
dollar $\text{beta}_{\text{i,t}}$			0.40		0.38	0.79
			[0.96]		[1.15]	[1.17]
$\text{MPS}_{\text{t,US}}$	0.11***	0.13***	−0.32			
	[4.30]	[3.49]	[1.00]			
carry $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$		0.07**		0.07		0.04
		[2.52]		[0.80]		[0.38]
dollar $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$			0.46		0.46	0.46
			[1.35]		[1.38]	[1.28]
$\Delta \log S_{i,t}$	−0.09	−0.09	−0.09	−0.08	−0.06	−0.07
	[0.73]	[0.85]	[0.73]	[0.44]	[0.31]	[0.40]
Overall R^2 in %	57.96	58.03	58.04	62.99	62.99	63.19
Avg. #Time periods	291	291	291	291	291	291
#Currencies	9	9	9	9	9	9
Currency FE	yes	yes	yes	yes	yes	yes
Time series FE	no	no	no	yes	yes	yes

Note: This table reports results from fixed effects panel regressions of the form $\log Loan_{i,t} = \mu_i + \alpha_t + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \gamma \Delta \log S_{i,t} + \epsilon_{i,t}$, where $\log Loan_{i,t}$ is the natural log of the dollar amount lent by global banks headquartered in the US to corporations domiciled abroad in currency i during month t. $X_{\text{i,t}}$ denotes either the *carry beta*$_{\text{i,t}}$ or *dollar beta*$_{\text{i,t}}$ that are based on rolling window regressions of currency excess returns on the carry and dollar factor, respectively. MPS_t is our monetary policy shock in basis points that we extract from Fed Fund futures rate changes around *scheduled* FOMC announcements following Kuttner (2001). $\Delta s_{i,t}$ is the log change in the spot exchange rate expressed as the number of foreign currency units per unit of US dollar. The independent variables are measured in units of standard deviations. The test statistics based on double clustered (by currencies and time) standard errors, allowing for first-order serial correlation are reported in brackets. Asterisks *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. The sample spans from January 2000 to March 2024.