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 towards currencies with greater systematic risk. The effects of monetary policy on flows of foreign exchange and international bank lending persist for several months. We argue that the exchange rate factor structure is a lens through which we can understand the international transmission of US monetary policy.

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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 various currencies. Currencies with low or negative betas are considered safe investments and earn small returns, whereas high-beta currencies are risky and their holders are compensated with large returns. But can these exposures enlighten economists beyond a currency's expected return and risk? Do exchange rate factors connect more broadly to other economic phenomena?

In this paper, we show that US monetary policy shocks are transmitted internationally through the exchange rate factor structure. For example, following an unexpected easing in the policy rate of the Federal Open Market Committee (FOMC), 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 out of safe currencies like the Japanese yen to buy risky ones like the Australian dollar. Global US banks, moreover, similarly reallocate their international loan origination activities from low- to high-risk currencies. Our mechanism is connected 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). Hence, we argue that the currency factor structure is a lens through which economists can understand how the real effects of monetary policy are transmitted to other countries.

We begin by analyzing the response of currency flows to US monetary policy announcements. One challenge that we face in our analysis is that currency flows and monetary policy are jointly determined. To overcome this challenge, we use the high-frequency changes in Federal Funds futures prices surrounding FOMC announcements as a source of discontinuity-based identification (Kuttner, 2001; Bernanke and Kuttner, 2005). Another challenge is that simply measuring flows in 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 spot and derivative markets alike. We discuss these data along with our other auxiliary data 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 with measures of systematic currency risk.

Next, we assess how measures of systematic currency risk direct flows in response to monetary policy surprises. We focus on carry and dollar betas following Verdelhan (2018). These betas encapsulate the set of a country's characteristics that collectively determine its currency's risk. Currencies with large carry betas tend to possess high interest rates (Lustig and Verdelhan, 2007), whereas currencies with larger dollar betas, among other things, face greater impediments to trade in goods (Lustig and Richmond, 2019). The high-carry-beta currencies are typically the investment leg of the well-known carry trade strategy. We find that both carry and dollar betas influence the direction and magnitude of investment funds' currency flows. Specifically, funds reallocate positions from low- to high-risk currencies following a monetary easing in the US, and vice versa.

In Section IV we turn from studying contemporaneous responses to examining long-lasting effects. We look at both purchases of forward contracts and cumulative changes in spot market flows of investment funds. Subsequent to a monetary easing, we find that funds primarily buy currency forwards with a one-month maturity. This is consistent with Lustig, Stathopoulos, and Verdelhan (2019) who show that carry trade returns are most significant in short-term assets. To study cumulative purchases in spot markets, we aggregate fund flows into three portfolios formed by carry betas to isolate a common response across currencies that differ only by their risk. Currencies with low carry betas tend to experience outflows following an easing, whereas currencies in the high carry beta portfolio face a lasting wave of demand. These effects are long-lived. The demand for risky currencies induced by an expansionary surprise persists beyond six months.

In addition to investment funds, banks also play an outsized role in currency markets, as market makers that provide liquidity to clients. However, the anonymized nature of the CLS data, unfortunately, does not permit us to analyze within-bank or bank-to-bank transactions. We therefore turn to global US banks' loan origination to study how changes in US monetary policy affect their risk-taking.

We show two key results regarding global US banks' lending patterns in Section V. First, in line with Bräuning and Ivashina (2020a), we find that a reduction in US rates leads to less foreign currency lending by banks that are domiciled in the US. Second, the magnitude of this decline is affected by the currency of the loan. Loans in safe currencies witness the largest decline, whereas loans in riskier currencies experience a smaller decline in lending or even loan growth. Thus, banks tilt their lending portfolios toward riskier currencies following a monetary easing.

Because we find significant effects in our panel regressions using currency risk measures that do not contain any direct information on interest rates, it is unlikely that they are the sole driver of shifts in foreign currency lending. Rather, we argue that systematic currency risk provides a unifying perspective toward understanding how monetary policy is transmitted internationally.

Related Literature

Since Fama (1984), an extensive literature in international finance has studied the economic reasons for why deviations from uncovered interest rate parity (UIP) persist. One enduring view is organized around systematic currency risk. Indeed, many authors 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. These exposures, in turn, have been shown to be related to the fundamental characteristics of countries.[1] 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 example, studies impulse responses of international macroeconomic variables to

[1] For example, a country's characteristic like its interest rate (Lustig et al., 2011), exposure to global volatility (Menkhoff, Sarno, Schmeling, and Schrimpf, 2012), 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.

structural shocks (Eichenbaum and Evans, 1995; Stavrakeva and Tang, 2015; Schmitt-Grohé and Uribe, 2018). Instead, our work uses 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). Recent papers examine the dynamics of various assets that are driven by FOMC announcements. A selected sample of papers that studies 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 US dollar and buys foreign currency earns high excess returns during days with announcements. In contemporaneous work, 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 help to explain the cross-sectional heterogeneity of these exposures across currencies and time.

We depart from this literature in two 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.

Our study aims to connect the exchange rate factor structure to the real international transmission of US monetary policy.[2] 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, but does not consider the impact 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, Paligorova, Sapriza, and Zlate (2021) analyze the impact of monetary policy on bilateral cross-border bank flows using the Bank of International Settlement's locational banking statistics database. Their focus is on policy rate changes abroad rather than in the US and they provide

[2] 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).

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.

Finally, we contribute to the foreign exchange (FX) microstructure literature. Starting from the seminal work by Evans (2002) and Evans and Lyons (2002a, 2005) several papers have studied the relationship between order flow and exchange rate dynamics.[3] Our key contribution is to provide new evidence on order flow dynamics surrounding monetary policy announcements and to link these dynamics to established measures of systematic currency risk.

II. Data and Summary Statistics

Our three primary databases span exchange rates, currency flows, and global loan origination. We use our data on exchange rates and secondary sources provided by other authors to compute measures of systematic currency risk. We construct monetary policy shocks following Kuttner (2001). 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 use mid prices when calculating returns and compute relative bid-ask spreads to measure liquidity.

[3] This vast literature on FX order flow includes, for example, Payne (2003); Bjønnes and Rime (2005); Evans and Lyons (2008); Breedon and Vitale (2010); Evans (2010); Menkhoff and Schmeling (2010); Rime, Sarno, and Sojli (2010); Mancini, Ranaldo, and Wrampelmeyer (2013).

For each currency i, we define the currency excess return at time t as

$$RX_{i,t}(m) = \log F_{i,t-m} - \log S_{i,t}, \tag{1}$$

where $F_{i,t-m}$ is the price of a forward contract entered into $m > 0$ periods ago that matures at time t, $S_{i,t}$ is the spot exchange rate at time t, and $RX_{i,t}(m)$ is the currency excess return at time t from entering into a forward at time $t - m$ that is then subsequently closed out at time t. An increase in F or S corresponds to an appreciation of the US dollar relative to the foreign currency.

During normal market periods, forward rates must satisfy the covered interest rate parity condition. Under this condition, the excess return equals the interest rate differential minus the appreciation of the US dollar. We use forward and spot prices to compute interest rate differentials. This excess return is equivalent to a carry trade position whereby one borrows in dollars to invest in a foreign currency for m periods.

The most common frequency analyzed by the FX asset pricing literature is monthly (e.g., Lustig and Verdelhan, 2007; Lustig et al., 2011). Hence, we also focus on one-month excess returns that we measure as follows

$$\begin{aligned} RX_{i,t} &= (\log F_{i,t-1} - \log S_{i,t}) - \Delta \log S_{i,t} \\ &\approx (r_{i,t-1} - r_{t-1}) - \Delta \log S_{i,t}, \end{aligned} \tag{2}$$

where r_i and r denote the foreign and domestic nominal one-month risk-free rates.

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 20 to 80 percent of exchange rate movements of developed countries.

The dollar and carry factors mimic, respectively, the first and second principal components of carry trade returns (which include interest rate differentials) but differ because they possess an economic interpretation. The dollar factor is the average change in all currencies with respect to the US dollar. The carry factor corresponds to the long-short portfolio return of a self-financing trading strategy that invests in high interest rate currencies and borrows in low interest rate currencies.

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 also 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 also 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. Hence, 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.

We follow Verdelhan (2018) and 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 both the dollar and carry factor:

$$\Delta \log S_{i,t} = a_i + \beta_i^{DOL} Dollar_t + \beta_i^{CAR} Carry_t + \epsilon_{i,t}, \tag{3}$$

where the $Dollar_t$ factor corresponds to the average change in the exchange rate between the US dollar and all other currencies, whereas the $Carry_t$ factor is a long-short portfolio return that we derive from sorting currencies into three portfolios based on the one-month forward discount relative to the US dollar prevailing over the previous month. The "high" portfolio consists of currencies with the highest interest rates relative to the US, whereas the opposite holds for the "low" portfolio. The carry return is the difference between these two portfolios. We consider a large cross-section of 18 currencies (to match our DealScan sample) against the US dollar to construct both the dollar and carry factor, respectively.

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. In sum, 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. Both currency markets (Andersen, Bollerslev, Diebold, and Vega, 2003) and bank lending (Bräuning and Ivashina, 2020a) are known to react strongly to changes in central bank policy (target) rates. We follow Kuttner (2001) to measure the one-day monetary policy target rate surprise as follows:

$$MPS_t = (ff_t^0 - ff_{t-1}^0)\frac{m}{m-t}, \tag{4}$$

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. 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. We analyze other measures of monetary policy shocks in Section VI.

To aggregate high-frequency shocks to the monthly frequency we simply aggregate by summing all the shocks within 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. All our empirical results in the subsequent sections 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 standard deviation across measures is near 10 basis points. The median realization for all shocks is zero.

D. Currency Flow Data

Our currency flow data comes from CLS Group, which operates the world's largest multi-currency cash settlement system and handles nearly 50 percent of global FX trading volume. 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

Table 1. Summary Statistics of Monetary Policy Shocks

	High-frequency	Simple sum	Weighted sum
Mean	1.22	1.25	0.82
Median	0.00	0.00	0.00
Std.	8.40	9.17	7.81
Min.	−24.89	−24.89	−24.89
Max.	74.06	83.24	72.43
#Obs	201	196	196

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. (4). The column labelled "Simple sum" aggregates the high-frequency shocks by simply summing up all shocks within a month, whereas the column labelled "Weighted sum" aggregates the shocks to a monthly frequency using the weighted average method described in the main text.

players.[4] Currencies are traded in spot, forward, and swap markets. The latter two products are distinguished by various maturity buckets.

Our CLS data sample of currency flows starts 1 September 2012 and ends 31 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).[5] In robustness, we extend the cross-section to include the less heavily traded 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 type. There are two broad classifications of market participants: dealer banks and customers. Dealer banks are market makers that quote prices.[6] There are four groups of price-taking customers:

[4] This data set is available from CLS Group and has been used in prior research. A short list is 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). Collectively, these authors have comprehensively described the CLS data.

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

[6] 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.

- 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 customer group j,

$$OF(Y_{ij,t}) = \text{Buy Volume}_{ij,t} \text{ in } \$ - \text{Sell Volume}_{ij,t} \text{ in } \$, \tag{5}$$

where Y denotes the asset in question (i.e., 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 2019. We see that the order flow attributed to funds in the last column is the largest in magnitude for this data point. Specifically, the order flow to exchange dollars for euros 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	sell_volume_USD	buy_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. To avoid double-counting, CLS excludes transactions between two dealer banks or two non-dealer banks.

Although CLS operates 5.5 days per week from 10pm CET Sunday evening to 2 am Saturday morning the vast majority of settlement instructions are received during the so-called London trading hours from 8am to 5pm GMT (Ranaldo and Somogyi,

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.

2021).[7] The results that we report below are based on this subsample but are similar to those based on the 24 hour trading day. 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-term impact of monetary policy on currency flows rather than the high-frequency intraday response.

Table 2 presents summary statistics for spot currency flows broken down by customer types and currency pairs. We report standard deviations and the share of each currency pair's trading volume that is accounted for by each customer group. Our focus on standard deviations (rather than averages) is motivated by the fact that mean currency flows are close to zero. Funds and non-dealer banks generate, by far, the most directional currency flows as measured by their standard deviation. 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 total volume across all currency pairs.

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

E. Global Banks' Loan Origination

We use the Thomson Reuters DealScan database for global corporate loan issuance. It primarily covers syndicated loans, which tend to be larger than non-syndicated loans. Bräuning and Ivashina (2020a) estimate 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

[7] This is not an anomaly of the CLS currency flow data but a general feature of the FX market that has been well-documented using various other data sources (see, e.g., Evans and Lyons, 2002a,b).

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

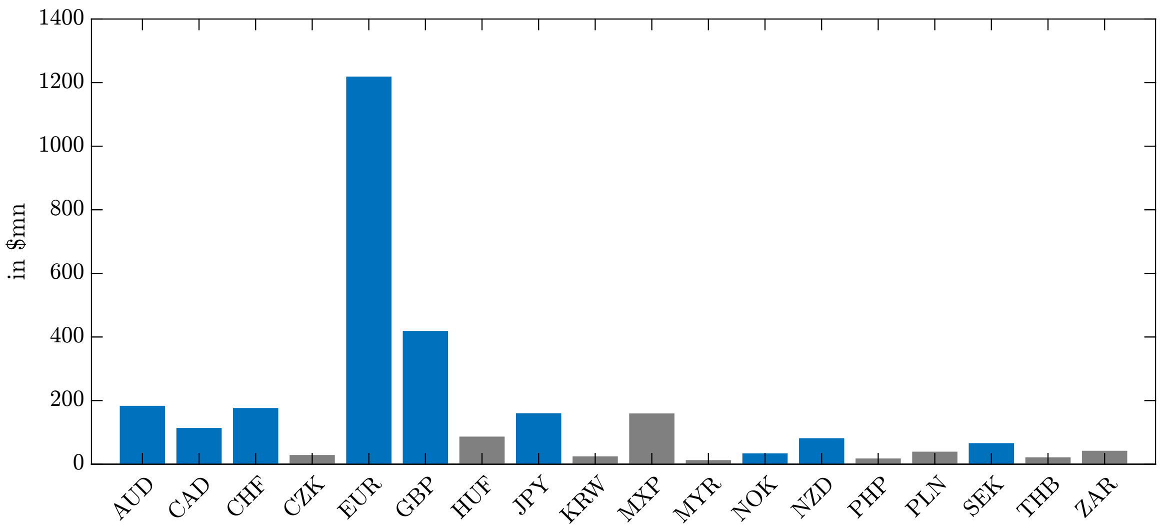
Note: This table collects simple summary statistics for the CLS order flow data. The columns labelled *Std.* report the standard deviation of monthly order flows (buy volume minus sell volume) in $bn broken down by four categories of market participants, namely, corporates, funds, non-bank financials (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.

details such as the amount (broken down by each lender) and currency. The data span from January 2000 to March 2024.

Given that we focus on US monetary policy transmission we filter for syndicated loans that involve at least one US bank. Specifically, we define *global US banks* as those that are domiciled in the US but are internationally active in the sense that they provide foreign currency loans. Next, for each global US bank and every given month, we aggregate all their loans originated in each foreign currency by leveraging information about the share that each bank is lending within a syndicate.

For our final sample we consider 18 currencies: Australian dollar, British pound, Canadian dollar, Czech koruna, euro, Hungarian forint, Japanese yen, Korean won, Malaysian ringgit, Mexican peso, New Zealand dollar, Norwegian krone, Polish zloty, Philippine peso, South African rand, Swedish krona, Swiss franc, and Thai baht. Figure 2 provides an overview of the data broken down by foreign currency. Similar to global currency market trading activity, foreign currency lending by US banks concentrates in G10 currencies. For instance, US banks lend on average $1,219mn in EUR and $419mn in GBP each month, whereas they lend less than $25mn in the Malaysian ringgit or Philippine peso.

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.

III. Contemporaneous Response of Currency Flows

Following the literature on financial market dynamics surrounding FOMC announcements (for example, Savor and Wilson, 2014; Mueller et al., 2017; Ai and Bansal, 2018), in this section we analyze the contemporaneous effects of these announcements on currency market flows. In contrast to this literature, we concern ourselves with the long-lasting transmission of monetary policy rather than the high-frequency impact on asset prices. We thus analyze flows during the whole calendar month that includes the days preceding and succeeding the announcement.

A. Customer Currency Flows Induced by Monetary Policy

We begin by running regressions of customer flows on our measure of monetary policy surprises to understand how each customer group responds to policy shocks. We run a time series regression for each group j for each currency i as follows:

$$OF(S_{ij,t}) = a_{ij} + \beta_{ij} MPS_t + \epsilon_{ij,t}. \tag{6}$$

We call the estimated slope coefficients, β_{ij}, *flow betas*. They measure in US dollars the magnitude of flows into foreign currency i by customer group j in response to an unexpected one basis point decline in the Federal Funds rate. Because an expansionary shock raises Federal Funds futures prices, MPS, we would expect it to produce positive order flow into foreign currencies as the opportunity cost of holding dollars increases. Hence, we expect that $\beta_{ij} > 0$.

Table 3 tabulates flow betas across our set of ten dollar-based currency pairs and customer 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 beta, respectively.

Looking at investment funds' flow betas across currencies we see that low carry currencies tend to possess negative flow betas, at least in cases when the betas are statistically significant. As carry betas begin to increase and turn positive, we see that 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 7.1 percent of a standard deviation per basis point surprise.

Corporate customers tend to have flows that appear to move oppositely to fund flows, that is, when US rates fall unexpectedly, corporations appear to buy low interest rate currencies and sell high-rate ones. However, the economic magnitude of these corporate flows is much smaller than the ones generated by funds.

Among all customer groups, 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). We believe this result is consistent with the notion that these institutions are "noise traders" in the sense that their flows do not respond strongly to fundamental information like monetary policy announcements.

Finally, turning to banks, we note that it is usually large broker-dealers that

Table 3. Flow Betas for G10 Currency Pairs

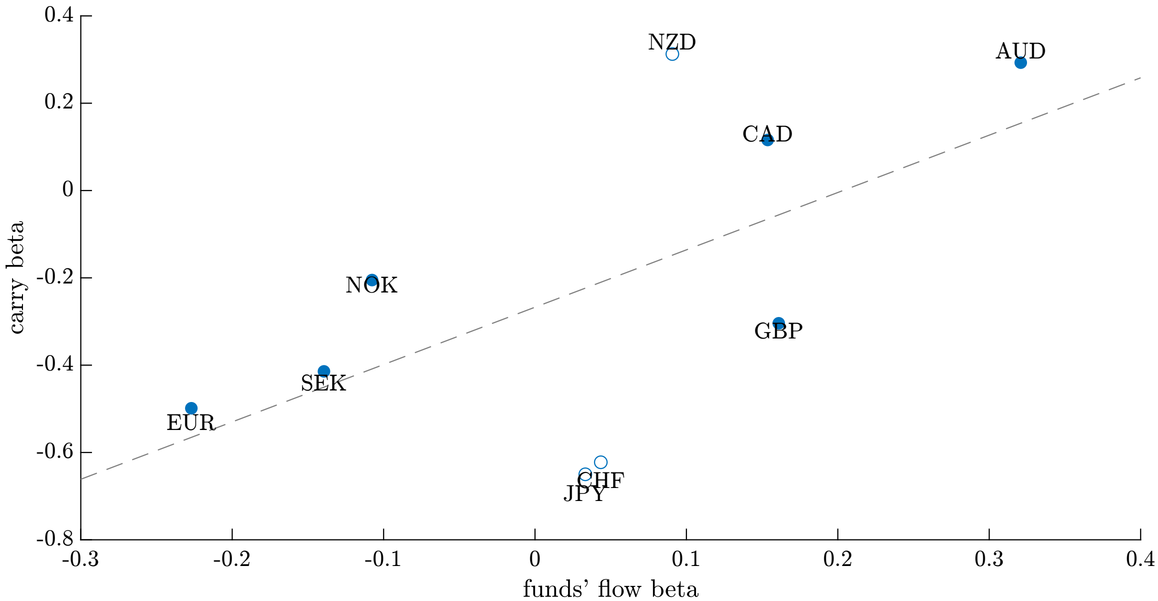
	Corporates	Funds	NBFIs	Non-dealer banks	carry beta	dollar beta
USDJPY	8.04	35.88	14.42	−246.79***	−0.65	0.76
	[0.56]	[0.74]	[1.03]	[4.73]		
USDCHF	7.08	23.51	−10.85	−15.52	−0.62	1.09
	[0.76]	[0.42]	[0.67]	[0.57]		
USDEUR	31.47	−580.18***	16.15*	−62.86	−0.50	1.15
	[0.95]	[4.57]	[1.86]	[0.40]		
USDSEK	4.17**	−30.21***	−2.18	20.67	−0.41	1.25
	[2.54]	[3.14]	[1.38]	[1.03]		
USDGBP	−72.82***	210.39***	−25.46*	27.04	−0.30	0.82
	[2.90]	[3.38]	[1.76]	[0.18]		
USDNOK	−4.39**	−13.99***	−1.19	−47.26***	−0.21	1.26
	[2.12]	[3.33]	[1.15]	[4.60]		
USDCAD	2.18	537.22***	25.06	500.92	0.12	0.64
	[0.46]	[5.67]	[1.51]	[1.62]		
USDAUD	−0.02	190.42***	1.03	−213.38***	0.29	1.16
	[0.00]	[5.23]	[0.20]	[3.42]		
USDNZD	−1.67	23.94	1.32	−49.58**	0.31	1.19
	[1.59]	[1.13]	[1.55]	[2.11]		

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 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.

make markets by providing liquidity to customers. We observe a similar behavior for smaller, non-dealer banks. Specifically, we find that non-dealer banks possess statistically significant coefficients for only negative flow betas. Negative betas indicate that these non-dealer banks tend to sell foreign currencies in response to an unexpected easing of US monetary policy. Thus, as money flows out from the US in response to a reduction in the Federal Funds rate, banks take the other side of the trade.

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 flows, changing from dollar inflows to dollar outflows. 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.

Figure 3. Funds' Currency Flow Betas and Carry Betas



Note: This figure plots the β regression coefficients 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.

B. Decomposing Flow Betas by Investment Funds

We have previously identified funds as a major player in generating currency flows around monetary policy announcements. Moreover, funds also appear to rebalance up the spectrum of systematic currency risk following expansionary shocks.

Against this backdrop, we now proceed to decompose the determinants of investment funds' currency flows. We do this by running a regression that controls for a set of country characteristics, X_i, and that interacts these characteristics with our monetary policy shock, MPS_t. Specifically, we estimate the following panel regression:

$$OF(S_{i,t}) = \mu_i + \alpha_t + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \kappa' \mathbf{W}_{i,t} + \epsilon_{i,t}, \qquad (7)$$

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 liquidity, measured by log change in the relative bid-ask spread, and log exchange rate returns. 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. Because 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 global currency flows. We consider both dollar and carry betas as country-level risk characteristics that are known to measure systematic risk in currency markets. We report regression results with standardized coefficients.

Table 4 tabulates the results of estimating Eq. (7) for funds' currency flows conditional on our two key measures of systematic currency risk. Column (1) shows that, as expected, a surprise decline in the Fed Funds rate (an increase in MPS) causes an outflow from the US. And vice versa, a surprise tightening induces dollar inflows.

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, a one-standard deviation US monetary policy shock is transmitted by raising flows into the foreign country by approximately 0.08 of a standard deviation of their usual flow. This magnitude is almost triple compared to the point estimate of 0.03 in column (1).

Next, we analyze how systematic currency risk impacts the cross-section of currency flows. Raising the carry beta by one standard deviation substantially magnifies the response. The effect of the monetary policy shock contributes to $0.08 + 0.1 = 0.18$ of a standard deviation of flows, equating to around six times the baseline response. In the context of the Australian dollar, this amounts to a directional flow of $0.18 \times \$2.65\text{bn} = \$0.47\text{bn}$ per one standard deviation move in our monetary policy shock measure.

The greater the currency's carry beta, the larger the order flow. 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 an unexpected reduction in the Federal Funds rate. For example, a country with a carry beta that is one standard deviation below the mean experiences a net outflow of $0.08 - 0.1 = -0.02$ standard deviations. Put differently, if the currency's carry beta is sufficiently negative, it produces the exact opposite effect: an unexpected easing of US monetary policy is associated with larger flows into the US dollar. Collectively, these effects show a systematic rebalancing of funds' currency positions and are 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.

Focusing on dollar betas, we find the exact opposite effect. Specifically, column (3) shows that currencies with greater dollar betas experience outflows following an unexpected easing of monetary policy. This may not be surprising as dollar betas summarise a wide range of economic characteristics. As an example, "distance" in gravity refers not only to physical distance but also to common language, culture, and customs. Moreover, countries that have different legal systems or are differentially friendly to foreign capital and international trade tend to be "further" away from the US. As a result, there is an inverse relationship between the size of financial flows between two countries and their dollar betas (Lustig and Richmond, 2019). This reasoning could partly explain the negative coefficient on dollar betas. In terms of economic magnitudes, the effects of a larger exposure to the dollar factor are similar to a one-standard deviation shift in carry betas: currency inflows decrease by approximately 0.08 of a standard deviation.

Including time fixed effects in columns (4) and (5) shows that the interaction coefficients with carry and dollar betas are not driven by any unobservable global factors. Finally, in column (6) we include both dollar and carry betas in the same regression. Both carry and dollar betas retain their sign and explanatory power. This is well expected, given that dollar and carry betas are jointly estimated such that they capture orthogonal sources of systematic currency risk.

Table 4. Currency Flows by Investment Funds and the FX Factor Structure

	(1)	(2)	(3)	(4)	(5)	(6)
carry $\text{beta}_{\text{i,t}}$		0.01		0.05		−0.01
		[0.20]		[1.28]		[0.13]
dollar $\text{beta}_{\text{i,t}}$			−0.18***		−0.13*	−0.17***
			[2.67]		[1.95]	[2.61]
MPS_{t}	0.03**	0.08***	0.11**			0.24***
	[2.41]	[5.19]	[2.21]			[4.27]
carry $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$		0.10***		0.11***		0.11***
		[8.79]		[8.68]		[10.11]
dollar $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$			−0.08*		−0.10**	−0.16***
			[1.69]		[2.24]	[3.58]
$\Delta \log$ bid-ask $\text{spread}_{\text{i,t}}$		0.02	0.02	0.00	0.00	0.01
		[1.19]	[1.25]	[0.12]	[0.10]	[0.56]
$\Delta \log S_{i,t}$		0.01	0.02	0.02	0.04	0.02
		[0.81]	[1.21]	[0.67]	[1.10]	[0.90]
Overall R^2 in %	18.76	19.65	19.73	31.12	30.71	20.67
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	no

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 Driscoll and Kraay's (1998) robust standard errors allowing for random clustering and 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.

IV. Persistent Effects of Currency Flows

We have shown that there is an impact on currency flows following an unexpected change in US monetary policy that occurs contemporaneously in the same calendar month. However, monetary policy affects the economy with a lag. Common estimates place the lag between money supply growth and its impact on inflation at one-and-a-half to two years. Asset markets, whose prices contain forward-looking information, of course, respond much more rapidly. To connect the persistent impact of flows in response to monetary policy shocks, we study currency flows in forward contracts across various maturities and impulse response functions of spot currency flows.

A. 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. Our regression is as follows

$$OF(F_{i,t+m}) = \mu_i + \alpha_t + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \kappa' \mathbf{W}_{i,t} + \epsilon_{i,t+m}, \quad (8)$$

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 5 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 or dollar betas pick up following a monetary expansion. Specifically, the interaction terms for carry beta and dollar beta, when considered by themselves, confirm that riskier currencies receive disproportionately larger flows. In terms of economic magnitudes, a one standard deviation increase in 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 coefficients become statistically 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. This is consistent with the monetary policy shock having an economic effect 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 exactly implement the carry trade as forward contracts are but one method to do so among several others. Alternatively, funds can buy some foreign currency in the spot market (see Section III) 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.

B. Impulse Response of Spot Currency Flows

We now turn to studying the cumulative impact of spot market flows. In order to isolate the impact of currency risk on flows, we form three groups of currencies—low, medium, and high—based on their carry betas. We then sum all flows within each group. The aim of the 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 noise to contaminate the confidence intervals of the long-run impulse responses.

We estimate the impulse responses by using local projections following Jordà (2005). We regress currency flows at various horizons on lags of our monetary policy shock. For each group g, the local projections are as follows:

$$OF(S^g_{t,t+h}) = \alpha^g_h + \sum_{m=0}^{3} \beta^g_{h,m} MPS_{t-m} + \epsilon^g_{t+h}, \tag{9}$$

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 impulse responses of funds' spot currency flows by reporting the coefficient $\beta^g_{h,0}$ for the low- and high-carry-beta group, respectively. We

Table 5. Forward Currency Flows by Investment Funds across Maturities

	1M		3M		12M	
	(1)	(2)	(3)	(4)	(5)	(6)
carry $\text{beta}_{\text{i,t}}$	−0.22***		0.05		0.10**	
	[3.95]		[1.42]		[2.16]	
dollar $\text{beta}_{\text{i,t}}$		0.27***		0.17***		0.04
		[7.11]		[5.27]		[0.71]
carry $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$	0.03***		0.02*		−0.08***	
	[2.59]		[1.75]		[5.65]	
dollar $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$		0.09**		0.00		−0.07
		[2.08]		[0.00]		[1.33]
Δ log bid-ask $\text{spread}_{\text{i,t}}$	−0.01	0.00	−0.01	−0.01	0.02	0.00
	[0.18]	[0.04]	[0.69]	[0.58]	[0.67]	[0.09]
$\Delta \log S_{i,t}$	0.03	0.04*	0.01	0.02	0.02	0.01
	[1.19]	[1.69]	[0.69]	[0.84]	[0.70]	[0.26]
Overall R^2 in %	61.98	63.19	62.83	63.54	32.39	31.83
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

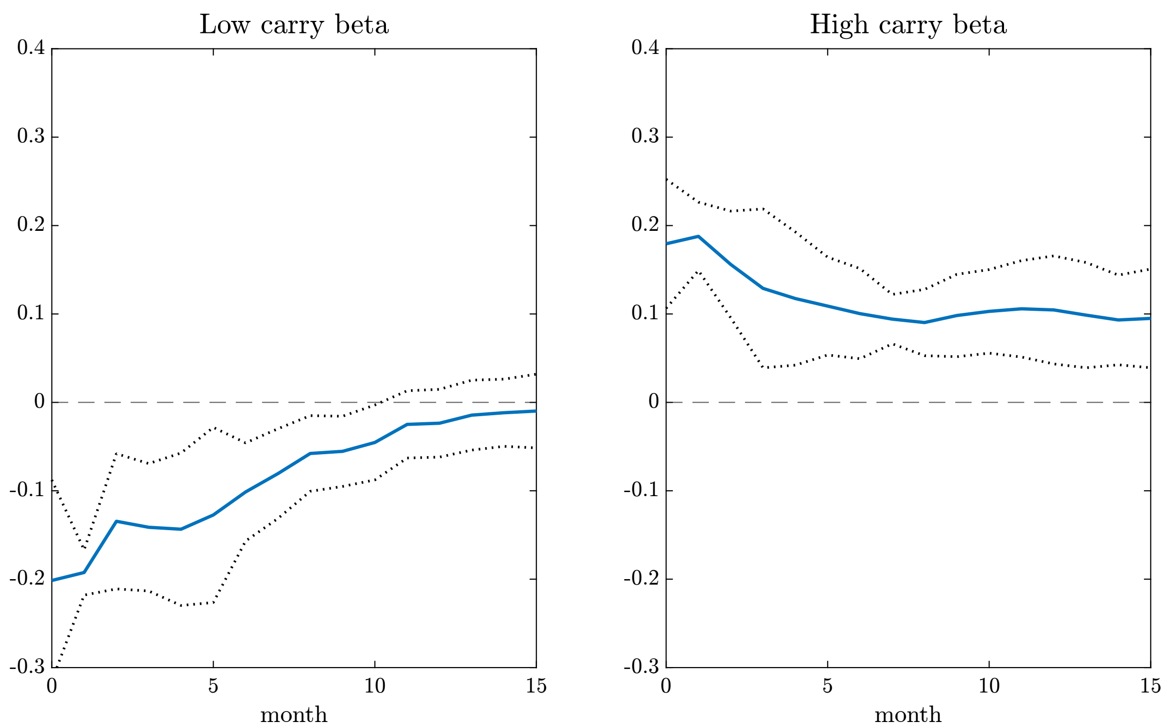
Note: This table reports results from fixed effects panel regressions of the form $OF(F_{i,t+m}) = \mu_i + \alpha_t + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \kappa' \mathbf{W}_{i,t} + \epsilon_{i,t+m}$, where $OF(F_{i,t+m})$ is the $m = 1, 3$ or 12 months forward flow by *funds* measured in \$bn in currency pair i in month t. $X_{\text{i,t}}$ 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 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*$_{\text{i,t}}$ 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 Driscoll and Kraay's (1998) robust standard errors allowing for random clustering and 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.

see that currencies in the low-carry-beta group experience an outflow following an expansionary monetary policy shock. 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 ten months.

On the contrary, the group of high-carry-beta currencies, which have positive carry betas (i.e., higher interest rates than the US), has a longer response horizon. Specifically, an unexpected expansion of US monetary policy causes a lasting 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. Safe currencies are sold by investment funds, while risky currencies are bought. This rebalancing across the risk spectrum of currencies is persistent, as a transient monetary policy shock generates a response that lasts over several quarters.

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 Hodrick (1992) standard errors correcting for the autocorrelation induced by overlapping periods. The sample covers the period from September 2012 to March 2024.

V. Global Banks' Loan Origination

Our evidence in the previous two sections points toward funds being one of the central players in the transmission of monetary policy. However, Table 2 indicates that banks, acting as both price-takers and market makers, are also responsible for regularly intermediating a large quantity of flows of foreign exchange. The anonymized structure of the CLS data, however, does not permit us to track within-bank or between-bank transactions. Moreover, while funds typically operate exclusively in secondary market transactions, one of banks' main purposes is to originate loans, that is, to participate in the primary market. Indeed, global bank loans constitute nearly half of external liabilities of emerging economies (Bräuning and Ivashina, 2020b). We, therefore, study banks' foreign currency loan origination decisions with an eye toward understanding the transmission of monetary policy to the real economy.

A. International Lending in Response to Monetary Policy Shocks

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

$$\log Loan_{i,t} = a_i + \beta_i MPS_t + \gamma_i \Delta \log S_{i,t} + \epsilon_{i,t}, \tag{10}$$

where $\log Loan_{i,t}$ is the log dollar amount lent by global US banks to corporations domiciled abroad in currency i during month t. Because all loan activity in DealScan is reported in US dollars, movements in the dollar exchange rate could mechanically influence loan volumes. Consequently, 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 our specification in Eq. (10), retain the credit betas, and plot them against our carry betas in Figure 5. We first note that 15 out of 18 currencies display negative credit betas in response to a loosening of US monetary policy. This result confirms 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 find it more attractive to lend domestically rather than hold reserves, and they then 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—the results in our broader currency sample largely confirm this mechanism.

The regression line in Figure 5 is upward sloping. This means that in response to monetary policy easing, global US banks lend more in currencies that bear more systematic risk. This is in line with the strategic risk-on pattern that we have shown for investment funds. Specifically, in Figure 3 we have shown that funds sell out of low-risk currencies to invest in risky ones following an expansionary monetary policy shock. Complementing this, we see that banks, analogously, increase their lending in risky currencies following a similar risk-on impetus. The key novelty here is to document this effect for banks' risk-taking behavior in primary markets.

B. International Lending and Currency Risk Factors

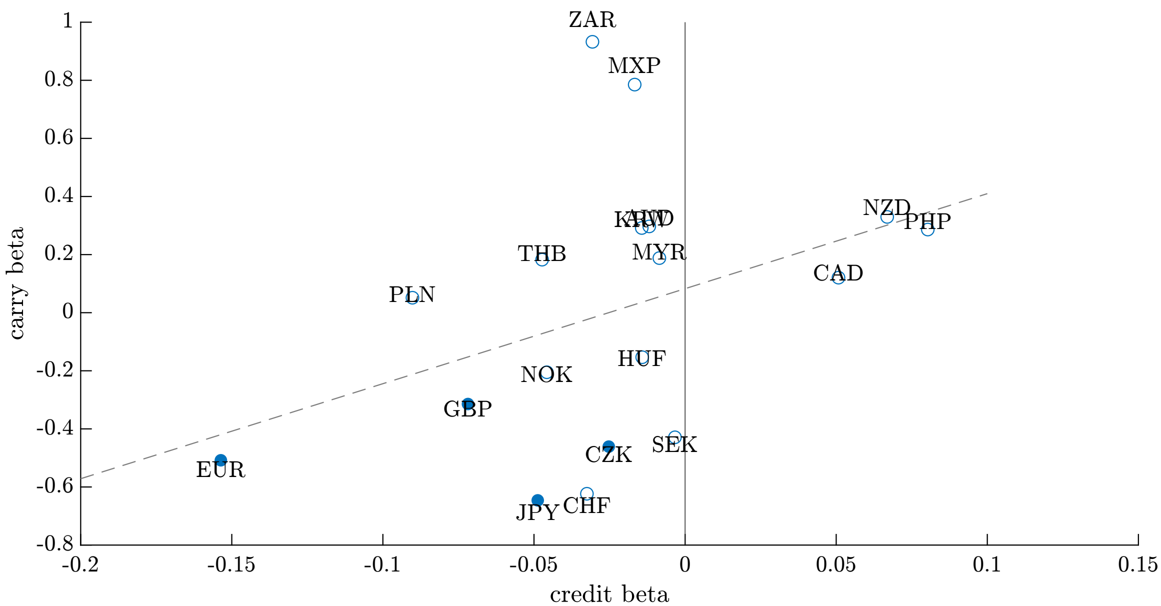
We further connect international lending to currency risk by using panel regressions. Specifically, we use them to decompose the determinants of global banks' foreign currency lending by controlling for country-level characteristics, X_i, that are known to correlate with systematic currency risk exposure; namely, dollar and carry betas. We estimate the following panel regression

$$\log Loan_{i,t} = \mu_i + \alpha_t + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \gamma \Delta \log S_{i,t} + \epsilon_{i,t}, \quad (11)$$

where we include both country- and time-fixed effects, μ_i and α_t. Our interaction term φ is the coefficient of interest. As before, X_i serves as an instrument through which the monetary policy shock MPS_t is transmitted to foreign loan origination. To mitigate the effect of outliers, we winsorize the dependent variable $\log Loan_{i,t}$ at the 1% level. We report regression results with standardized regressors.

Table 6 tabulates the results. Column (1) confirms the mechanism of Bräuning and Ivashina (2020a) and, loosely speaking, corresponds to the average of the point estimates displayed visually in Figure 5. Column (2) controls for the variation in carry betas. For a currency that has a zero carry beta, and therefore, possesses a similar interest rate as the US, a rate decline by one standard deviation reduces foreign lending by approximately 4 percent.

Figure 5. Foreign Credit Betas and Carry Betas



Note: This figure plots the regression coefficients (i.e., βs) 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 6 lags. The sample covers the period from January 2000 to March 2024.

The growth in foreign lending, however, is influenced by the degree of currency risk. Conditional on an unexpected easing of US monetary policy, foreign currencies with greater carry betas experience a smaller reduction in lending. For example, shifting up across the distribution of countries' carry betas by one-standard deviation offsets the reduction entirely, and produces a null effect. A shift by two standard deviations produces actual loan growth. Conversely, lower carry betas magnify the decline in lending. Hence, carry betas impact the intensity of banks' loan origination. Put differently, banks are "risk-on" in primary markets and tilt their loan origination toward riskier currencies as measured by their exposure to the carry factor.

In column (3) we control for variation in dollar betas. As before, the slope coefficient estimate is negative, reflecting the gravity effects of international trade that could proxy for impediments to financial trade. In columns (4) and (5), we run more stringent specifications that include time-fixed effects, controlling for omitted time-varying global factors. The interaction with carry betas remains positive and significant, whereas the interaction with dollar betas becomes insignificant. Thus, dollar betas, by themselves, do not seem to explain the response of foreign currency lending to changes in US monetary policy. Rather, dollar betas' impact on lending flows appears to be time-invariant, which is consistent with the determinants of the gravity equation being composed of relatively static variables.

Finally, in column (6) we find that carry betas drive out dollar betas in a horse race. Carry betas therefore appear to be the primary source of systematic currency risk that explains the heterogeneous response of banks' loan origination across foreign currencies.

In sum, global US banks decrease foreign currency lending in response to a loosening of US monetary policy. However, they tilt the distribution of their loans toward countries that have greater systematic currency risk. In some cases, the risk-taking channel that raises foreign lending could completely offset the decline of loans driven by the channel that operates through the opportunity cost of holding reserves.

VI. Extensions and Robustness

Here we summarise 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) contractionary vs expansionary monetary policy shocks, iv) other central banks' reactions to US monetary policy, v) alternative measures of monetary policy shocks, and v) European monetary policy shocks.

A. Economic Sources of Currency Risk

We explore the 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 (Della Corte et al., 2016), trade composition

Table 6. Foreign Currency Loan Origination and Currency Risk Factors

	(1)	(2)	(3)	(4)	(5)	(6)
carry $\text{beta}_{\text{i,t}}$		0.01		0.01		−0.01
		[0.31]		[0.20]		[0.23]
dollar $\text{beta}_{\text{i,t}}$			0.04*		0.04*	0.04
			[1.72]		[1.70]	[1.47]
MPS_{t}	−0.03**	−0.03**	0.01			0.01
	[2.06]	[2.03]	[0.34]			[0.39]
carry $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$		0.04***		0.04***		0.04***
		[3.20]		[3.59]		[3.42]
dollar $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$			−0.05*		−0.04	−0.05
			[1.69]		[1.63]	[1.60]
$\Delta \log S_{i,t}$	−0.03**	−0.03**	−0.03**	0.00	−0.01	−0.03**
	[2.20]	[2.04]	[2.24]	[0.12]	[0.42]	[2.09]
Overall R^2 in %	57.88	57.92	57.91	60.72	60.71	57.94
Avg. #Time periods	291	291	291	291	291	291
#Currencies	18	18	18	18	18	18
Currency FE	yes	yes	yes	yes	yes	yes
Time series FE	no	no	no	yes	yes	no

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 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 Driscoll and Kraay's (1998) robust standard errors allowing for random clustering and serial correlation up to 6 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.

(Ready et al., 2017), trade network centrality (Richmond, 2019), and term premia (Andrews, Colacito, Croce, and Gavazzoni, 2024). Table 7 presents the results from extending our core findings in Table 4 to these sources of country-level risk.

Countries that have higher interest rates as measured by their relative 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 a statistically identifiable response. In our sample, we do not find an identifiable response emanating from trade imbalance or 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 assets positions are note necessarily the countries with the highest interest rates.

Importantly, all of these measures 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 currency risk and not just interest rates shape the response of currency flows to monetary policy.

Table 7. Currency Flows of Funds and a Horse Race of Currency Risks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\mathrm{MPS_t}$	0.08***	0.10***	−0.03	0.04***	0.09***	0.12***	−0.08	−0.03**
	[5.19]	[3.99]	[0.92]	[2.62]	[3.41]	[4.48]	[0.50]	[2.55]
carry $\mathrm{beta_{i,t}} \times \mathrm{MPS_t}$	0.10***							
	[8.79]							
$f_{i,t} - s_{i,t} \times \mathrm{MPS_t}$		0.09***						
		[3.08]						
$\mathrm{centrality_{i,t}} \times \mathrm{MPS_t}$			−0.08**					
			[2.33]					
downside $\mathrm{beta_{i,t}} \times \mathrm{MPS_t}$				0.01				
				[0.67]				
term $\mathrm{premium_{i,t}} \times \mathrm{MPS_t}$					0.09*			
					[1.78]			
$\mathrm{size_{i,t}} \times \mathrm{MPS_t}$						−0.14***		
						[4.91]		
trade $\mathrm{imbalance_{i,t}} \times \mathrm{MPS_t}$							−0.01	
							[0.28]	
import $\mathrm{ratio_{i,t}} \times \mathrm{MPS_t}$								0.07***
								[7.69]
$\Delta \log$ bid-ask $\mathrm{spread_{i,t}}$	0.02	0.03*	0.04*	0.03	0.03*	0.04*	0.00	0.01
	[1.19]	[1.72]	[1.71]	[1.47]	[1.74]	[1.84]	[0.32]	[0.87]
$\Delta \log S_{i,t}$	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.02
	[0.81]	[1.02]	[0.87]	[0.87]	[0.90]	[0.67]	[0.29]	[0.86]
Overall R^2 in %	19.65	19.22	19.73	19.66	19.34	21.69	25.07	33.57
Avg. #Time periods	138	138	138	138	138	135	63	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: $\Delta \log$ *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 Driscoll and Kraay's (1998) robust standard errors allowing for random clustering and 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.

B. Persistent Currency Risk Factors

One possible concern is that currency risk characteristics are endogenous and quickly respond to monetary policy shocks. These currency risk characteristics, however, are very persistent over time. This persistence is a direct consequence of the lumbering macroeconomic fortune of an economy. Lustig et al. (2011) and Hassan and Mano (2018) 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.

Against this backdrop, we think of dollar and carry betas as being pre-determined in the econometric sense. To support this point, we provide details about the time-series and cross-sectional persistence of currency risk measures in the Online Appendix. In particular, we show that the first order autocorrelation coefficient is around 98% for both dollar and carry betas, respectively. Moreover, there is compelling evidence that the cross-sectional ranking of currencies is stable over time. For instance, the Japanese yen is 87% of the time part of the low-carry-beta portfolio, whereas the Mexican peso is almost always part of the high-carry-beta portfolio. We find similar effects for sorting based on dollar betas. Lastly, we estimate a simple panel regression of changes in dollar or carry betas on our monetary policy shock measure and find no evidence that changes in monetary policy impact systematic currency risk.

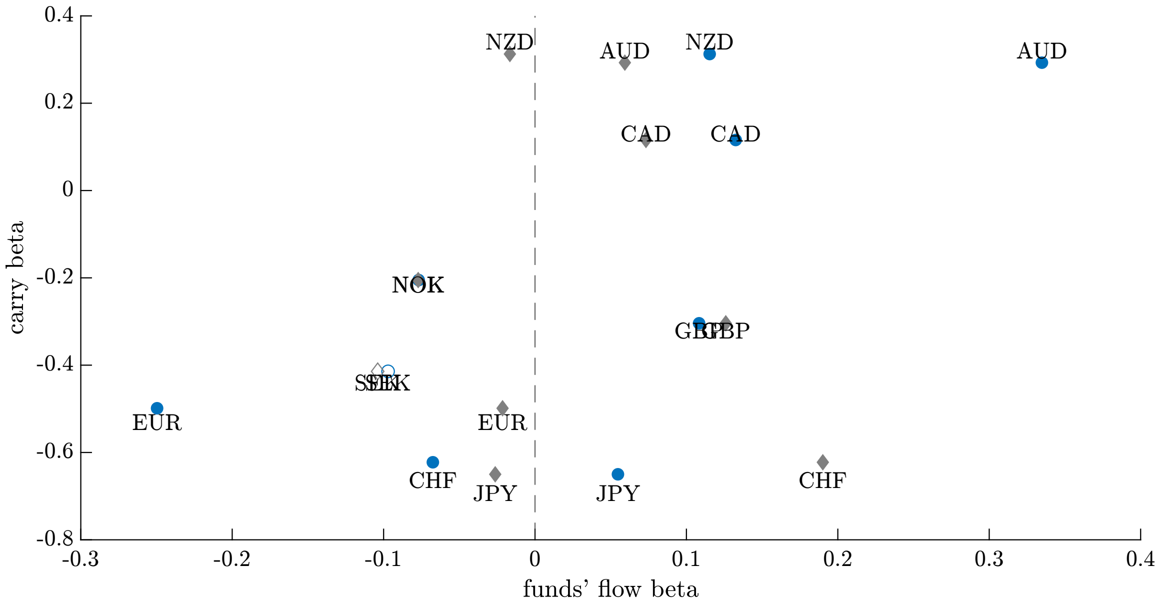
C. Expansionary and Contractionary Monetary Policy

Here we split our sample into periods of positive and negative monetary policy shocks. Specifically, we replicate Figure 3 for investment funds for each monetary period. The key observation is that monetary policy shocks have a stronger impact on currency flow 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 monetary policy having an asymmetric effect on real and financial variables.

D. 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

Figure 6. 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.

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 earned on reserve-like assets and not purposefully 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. Specifically, we estimate the following regression:

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

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. Our risk measures, $X_{i,t}$, are the dollar and carry betas.

Table 8 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; countries with negative carry exposures, like Japan, would tend to cut less or even raise rates. These patterns are opposite of what the alternative story would predict.

E. 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. Nakamura and Steinsson (2018) extract monetary policy surprises from changes in Eurodollar futures contracts at different horizons around FOMC meetings. Kearns, Schrimpf, and Xia (2022) build on the work by Swanson (2021) but take a simpler approach and construct target rate, path, and long-rate surprises. Jarociński and Karadi (2020) decompose monetary policy surprises into monetary policy and information shocks using the high frequency co-movement between interest rates and stock prices. We evaluate these other monetary shocks to confirm the robustness of our thesis.[8]

Table 9 replicates our results in Table 4 but using various different measures of monetary policy shocks. The evidence can be summarised along three dimensions: First, only the target factor shocks by Kearns et al. (2022) and Jarociński and Karadi (2020) have a significant positive unconditional impact on currency flows. Specifically,

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

Table 8. Predicting Foreign Policy Rates with Fed Fund Rates

	(1)	(2)	(3)	(4)	(5)
Δ FFR$_{\text{t-1}}$	0.26***	0.32***	0.37***		
	[4.94]	[4.33]	[4.85]		
carry beta$_{\text{i,t}}$		−0.15**		−0.14**	
		[2.27]		[2.43]	
dollar beta$_{\text{i,t}}$			0.02		0.05*
			[0.62]		[1.74]
carry beta$_{\text{i,t}}$ × Δ FFR$_{\text{t-1}}$		0.12***		0.13***	
		[2.60]		[3.00]	
dollar beta$_{\text{i,t}}$ × Δ FFR$_{\text{t-1}}$			−0.12		−0.07
			[1.27]		[0.81]
Overall R^2 in %	6.56	8.03	6.69	42.17	40.79
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. $X_{\text{i,t}}$ 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. Both dependent and independent variables are measured in units of standard deviations. The test statistics based on Driscoll and Kraay's (1998) robust standard errors allowing for random clustering and serial correlation up to 6 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.

monetary policy easing in the US is associated with larger flows into foreign currencies. Second, turning to the interaction effects with carry and dollar betas we find that once again only the target factor shocks by Kearns et al. (2022) and Jarociński and Karadi (2020) deliver consistent results with our baseline estimates using Kuttner (2001) shocks. Lastly, path and long-rate (Kearns et al., 2022), forward guidance Nakamura and Steinsson (2018), and central bank information (CBI) shocks (Jarociński and Karadi, 2020) are not associated with any significant foreign currency flows.

F. European Monetary Policy Shocks

The evidence so far has focused on the Federal Reserve's US monetary policy shocks and US dollar-based currency pairs. A natural question to ask is whether other central

Table 9. Investment Fund Flows and a Horse Race of Monetary Policy Shocks

	Kuttner (2001)	Nakamura and Steinsson (2018)	Kearns et al. (2022)			Jarociński and Karadi (2020)	
			Target	Path	Long-rate	MP	CBI
carry $\text{beta}_{\text{i,t}}$	−0.01	−0.02	−0.01	−0.02	−0.01	−0.01	−0.02
	[0.17]	[0.37]	[0.23]	[0.31]	[0.26]	[0.20]	[0.29]
dollar $\text{beta}_{\text{i,t}}$	−0.17***	−0.17***	−0.18***	−0.17**	−0.18***	−0.18***	−0.18***
	[2.64]	[2.66]	[2.68]	[2.50]	[2.67]	[2.78]	[2.71]
MPS_{t}	0.24***	0.05	0.21**	0.14	−0.13	0.26**	−0.06
	[4.27]	[0.39]	[2.19]	[0.74]	[0.85]	[2.27]	[0.72]
carry $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$	0.11***	0.04	0.11***	−0.01	−0.03	0.03	0.00
	[10.50]	[1.04]	[4.41]	[0.33]	[0.86]	[1.33]	[0.24]
dollar $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$	−0.17***	−0.04	−0.16**	−0.13	0.08	−0.21**	0.06
	[3.88]	[0.36]	[2.01]	[0.87]	[0.68]	[2.40]	[0.83]
Overall R^2 in %	20.67	19.75	20.66	19.79	19.84	20.12	19.62
Avg. #Time periods	139	139	139	139	139	139	139
#Currencies	9	9	9	9	9	9	9
Currency FE	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* $\textit{beta}_{\text{i,t}}$ 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. Both dependent and independent variables are measured in units of standard deviations. The test statistics based on Driscoll and Kraay's (1998) robust standard errors allowing for random clustering and 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.

bank monetary policy shocks matter for US currency flows and whether similar effects are present. We look at monetary shocks originating from the European Central Bank (ECB) and their impact on euro-based currency pairs.

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 (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 Miranda-Agrippino and Rey (2020).

In Table 10 we replicate the results in Table 3 but replace dollar-based currency pairs with euro-based (e.g., EURCHF or 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, we find no evidence that euro-based currency pairs actively respond to ECB monetary policy shocks.

Table 10. Flow Betas for Euro Currency Pairs

	Corporates	**Funds**	**NBFIs**	**Non-dealer banks**	carry beta	euro beta
EURJPY	0.08	0.18	0.05	−0.22*	−0.89	1.56
	[1.09]	[1.34]	[1.06]	[1.86]		
EURCHF	−0.22***	−0.12	−0.17*	−0.07	−0.38	0.57
	[4.14]	[0.78]	[1.89]	[1.09]		
EURUSD	−0.10	−0.15	0.09	−0.04	−0.07	1.46
	[0.90]	[1.30]	[1.20]	[0.74]		
EURDKK	0.04	0.06	0.14	−0.16***	0.00	0.01
	[0.23]	[0.89]	[1.52]	[2.79]		
EURSEK	−0.03	−0.07	0.01	0.12	0.00	0.65
	[0.42]	[0.98]	[0.07]	[1.19]		
EURGBP	−0.09	0.12	−0.07	−0.15*	0.02	1.01
	[1.01]	[1.63]	[0.85]	[1.84]		
EURNOK	0.06	−0.07	0.04	0.03	0.23	0.84
	[0.71]	[1.12]	[0.71]	[0.40]		
EURCAD	−0.04	−0.21	0.15**	0.12*	0.37	1.50
	[0.82]	[0.94]	[2.33]	[1.91]		
EURAUD	0.02	−0.02	−0.12*	0.17	0.69	1.36
	[0.23]	[0.21]	[1.93]	[1.37]		

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 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.

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 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. We find that investment funds direct flows from low-risk to high-risk currencies in response to an unexpected easing of US monetary policy. Global banks, too, tilt their foreign currency lending toward currencies that are most exposed to systematic currency risk. Both facts are consistent with the risk-taking channel of monetary policy. These flows are persistent and are most pronounced for countries that have different interest rates than the US. But interest rates are not the only country characteristic that matters. This is because we find evidence that currency risk measures that contain no direct information on interest rates similarly shape the response of both currency and lending flows.

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

Future work could look beyond the initial reaction of fund flows and loan decisions to examine real decisions by households and firms. We hope our findings spur work into similar ideas concerning other economic 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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Online Appendix — Not for Publication.

Appendix A. Additional Results

Table A.1. 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 A.2. Summary Statistics — DealScan

Currency	#Obs	Mean	Std.	5%	25%	50%	75%	95%
AUD	190	183.5	260.8	17.3	47.9	94.3	210.8	750.5
CAD	65	114.0	240.3	3.1	19.7	55.2	104.8	313.0
CHF	15	176.7	215.7	9.8	32.6	93.0	200.6	674.3
CZK	12	28.9	17.5	5.2	16.4	25.7	37.9	61.4
EUR	280	1,219.0	3,922.9	31.5	188.9	476.3	1,110.8	3,154.7
GBP	174	419.3	765.6	30.6	72.5	157.2	387.4	1,905.3
HUF	3	86.7	28.0	56.4	65.4	92.3	106.7	111.5
JPY	65	160.2	415.8	1.0	8.5	27.3	156.7	710.7
KRW	36	24.6	27.7	2.3	9.6	16.3	25.0	91.0
MXP	11	159.6	145.2	19.2	53.0	76.1	294.8	412.4
MYR	5	12.8	6.8	4.3	7.0	13.2	19.2	19.7
NOK	8	34.1	21.5	13.4	16.0	26.1	56.1	63.1
NZD	39	81.7	106.4	12.9	20.7	37.4	102.4	285.5
PHP	14	17.9	24.8	2.8	3.4	6.4	14.4	75.7
PLN	5	39.3	35.1	6.7	16.2	20.4	66.8	91.8
SEK	14	66.3	62.2	4.8	16.3	49.3	102.3	214.1
THB	6	21.6	23.5	2.0	5.1	12.0	35.0	63.3
ZAR	10	42.1	58.2	1.2	13.0	18.2	24.9	177.3

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 sum of all syndicated loans in a given currency aggregated over a month. The sample covers the period from January 2000 to March 2024.

Table A.3. Summary Statistics — DealScan by Currency and Country

	AUD	CAD	CHF	CZK	EUR	GBP	HUF	JPY	KRW	MXP	MYR	NOK	NZD	PHP	PLN	SEK	THB	ZAR	Total
Australia	378	3			6	7							6						400
Canada		65																	65
Switzerland			16		2	10		1											29
Czech Republic				10	3														13
Euro Area				2	850	26		1								1		1	881
United Kingdom	1				46	1						264							312
Hungary					5		3												8
Japan	1							69											70
South Korea					7			37	17										61
Mexico					2					12									14
Malaysia			2		9	3		1			3								18
Norway					10							5							15
New Zealand						41							2						43
Philippines					1			16						3					20
Poland			11		1										5				17
Sweden					27	1						1				12			41
Thailand								7									2		9
South Africa	1				5	1												9	16

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 A.4. Summary Statistics — Systematic Currency Risk Measures

	Carry beta				Dollar beta			
	T1	T2	T3	ACF	T1	T2	T3	ACF
USDAUD	0.00	32.30	67.70	98.82	0.34	59.79	39.86	97.73
USDCAD	0.00	67.01	32.99	98.83	77.32	22.68	0.00	99.01
USDCHF	86.25	13.75	0.00	99.52	26.80	49.83	23.37	98.98
USDCZK	88.66	6.53	4.81	97.84	0.00	3.78	96.22	98.06
USDEUR	100.00	0.00	0.00	97.69	1.37	63.92	34.71	98.85
USDGBP	63.92	35.74	0.34	97.65	33.68	66.32	0.00	98.39
USDHUF	36.08	53.26	10.65	99.53	3.78	8.93	87.29	98.36
USDJPY	87.29	12.71	0.00	99.71	66.32	29.90	3.78	99.17
USDKRW	0.69	28.52	70.79	97.84	56.70	31.27	12.03	97.88
USDMXP	0.00	0.34	99.66	97.24	69.42	22.68	7.90	99.11
USDMYR	2.41	53.61	43.99	98.77	71.13	21.31	7.56	98.84
USDNOK	11.68	87.97	0.34	97.67	5.84	44.33	49.83	98.42
USDNZD	3.78	18.90	77.32	98.34	0.00	69.76	30.24	99.22
USDPHP	0.00	54.64	45.36	98.97	90.03	6.53	3.44	99.00
USDPLN	11.68	62.20	26.12	99.75	11.68	15.81	72.51	98.80
USDSEK	97.94	2.06	0.00	98.22	1.03	38.49	60.48	99.06
USDTHB	9.62	68.73	21.65	99.40	74.91	12.71	12.37	99.02
USDZAR	0.00	1.72	98.28	99.08	9.62	31.96	58.42	98.42

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 87.29% 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. Higher reading corresponds to higher levels of time-series persistence. The sample covers the period from January 2000 to March 2024.

Table A.5. Monetary Policy Shocks and Systematic Currency Risk

	carry beta	dollar beta
$\mathrm{MPS_t}$	−0.004	0.004
	[1.056]	[0.958]
Overall R^2 in %	0.38	0.64
Avg. #Time periods	290	290
#Currencies	18	18
Currency FE	yes	yes
Time series FE	no	no

Note: This table reports results from monthly fixed effects panel regressions of the form $\Delta beta_{i,t} = \mu_i + \beta MPS_t \epsilon_{i,t}$, where the dependent variable (indicated in the column header) is either the change in the dollar or the carry beta and μ_i are currency fixed effects. MPS_t is our monetary policy shock in basis points that we extract from Fed Fund futures rate changes following Kuttner (2001). The test statistics based on Driscoll and Kraay's (1998) robust standard errors allowing for random clustering and serial correlation up to 6 lags are reported in brackets. Asterisks *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. The sample covers the period from January 2000 to March 2024.

Table A.6. Currency Flows of Funds and the FX Factor Structure — G10 + EMs

	(1)	(2)	(3)	(4)	(5)	(6)
carry $\text{beta}_{\text{i,t}}$		0.03		−0.04		0.03
		[0.47]		[0.73]		[0.44]
dollar $\text{beta}_{\text{i,t}}$			−0.10**		−0.12**	−0.10**
			[2.17]		[2.44]	[2.12]
MPS_{t}	0.02**	0.03**	0.10***			0.18***
	[1.98]	[2.41]	[2.78]			[5.48]
carry $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$		0.05***		0.05***		0.06***
		[2.82]		[2.85]		[3.02]
dollar $\text{beta}_{\text{i,t}} \times \text{MPS}_{\text{t}}$			−0.08**		−0.09***	−0.16***
			[2.47]		[2.82]	[5.35]
Δ log bid-ask $\text{spread}_{\text{i,t}}$		0.03*	0.02	0.02	0.00	0.02
		[1.69]	[1.21]	[0.69]	[0.00]	[1.14]
$\Delta \log S_{i,t}$		0.02	0.02	0.03	0.03	0.02
		[1.57]	[1.39]	[1.42]	[1.32]	[1.46]
Overall R^2 in %	20.88	21.12	21.28	29.62	29.88	21.58
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	no

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 Driscoll and Kraay's (1998) robust standard errors allowing for random clustering and 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.