Monetary Policy Transmission through the Exchange Rate Factor Structure

Erik Loualiche* Alexandre R. Pecora† Fabricius Somogyi‡ Colin Ward§

NBER Summer Institute 2025 — July 9, 2025

*University of Minnesota. E-mail: eloualic@umn.edu
†Virginia Tech. E-mail: alexpecora@vt.edu
‡Northeastern University. E-mail: f.somogyi@northeastern.edu
§University of Alberta. E-mail: colin.ward@ualberta.ca

Motivation: US Monetary Policy and FX Factor Structure

1. **US Monetary Policy Transmission**:
   - **US monetary policy** impacts **global economy**: *asset prices*, *bank lending*, *capital flows*, etc.

   ⇒ Why are some **countries affected** more by **US monetary policy** than others?

   ⇒ **Exchange rates** are pivotal in **transmitting monetary policy** across countries.

2. **FX Factor Structure**:
   - Lustig, Roussanov, and Verdelhan (2011), Verdelhan (2018): **dollar** and **carry**

$$\Delta FX_{i,t} = \alpha + \beta_i^{DOL} Dollar_t + \beta_i^{CAR} Carry_t + \epsilon_{i,t}$$

   - Chernov, Dahlquist, and Lochstoer (2023): unconditional mean-variance portfolio (**UMVE**)

$$\Delta FX_{i,t} = \alpha + \beta_i^{UMVE} UMVE_t + \epsilon_{i,t}$$

Motivation: US Monetary Policy and FX Factor Structure

1. **US Monetary Policy Transmission**:
   - **US monetary policy** impacts **global economy**: *asset prices*, *bank lending*, *capital flows*, etc.

   $\Rightarrow$ Why are some **countries affected** more by **US monetary policy** than others?

   $\Rightarrow$ **Exchange rates** are pivotal in **transmitting monetary policy** across countries.

2. **FX Factor Structure**:
   - Lustig, Roussanov, and Verdelhan (2011), Verdelhan (2018): **dollar** and **carry**

$$\Delta FX_{i,t} = \alpha + \beta_i^{DOL} Dollar_t + \beta_i^{CAR} Carry_t + \epsilon_{i,t}$$

   - Chernov, Dahlquist, and Lochstoer (2023): unconditional mean-variance portfolio (**UMVE**)

$$\Delta FX_{i,t} = \alpha + \beta_i^{UMVE} UMVE_t + \epsilon_{i,t}$$

Motivation: US Monetary Policy and FX Factor Structure

1. **US Monetary Policy Transmission**:
   - **US monetary policy** impacts **global economy**: *asset prices*, *bank lending*, *capital flows*, etc.

   $\Rightarrow$ Why are some **countries affected** more by **US monetary policy** than others?

   $\Rightarrow$ **Exchange rates** are pivotal in **transmitting monetary policy** across countries.

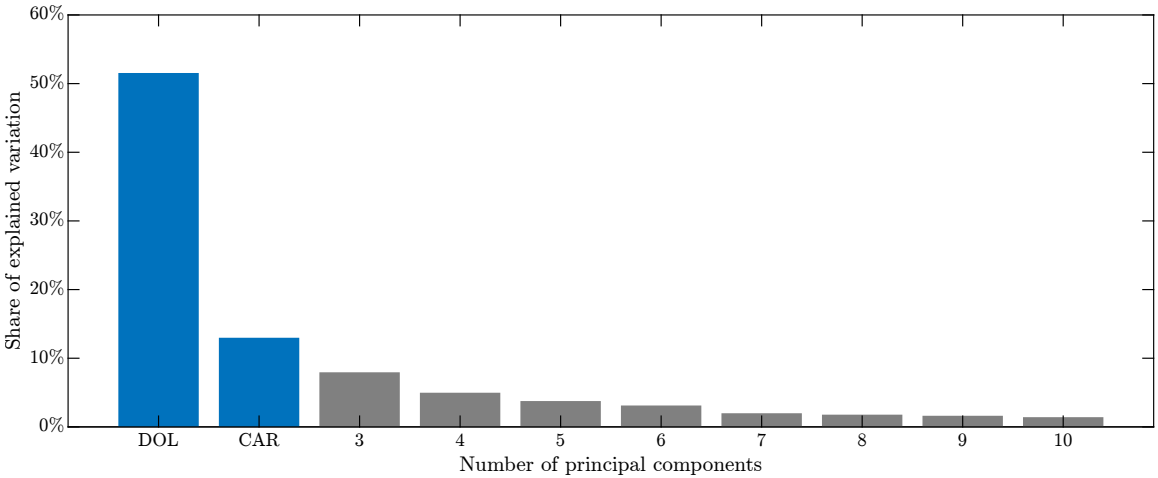
2. **FX Factor Structure**:
   - Lustig, Roussanov, and Verdelhan (2011), Verdelhan (2018): **dollar** and **carry**

$$\Delta FX_{i,t} = \alpha + \beta_i^{DOL} Dollar_t + \beta_i^{CAR} Carry_t + \epsilon_{i,t}$$

   - Chernov, Dahlquist, and Lochstoer (2023): unconditional mean-variance portfolio (**UMVE**)

$$\Delta FX_{i,t} = \alpha + \beta_i^{UMVE} UMVE_t + \epsilon_{i,t}$$

Exchange Rates Follow a Strong Factor Structure



Note: Sample covers 28 currency pairs and spans the monthly period from January 2000 to March 2024.

Motivation: US Monetary Policy and FX Factor Structure

1. **US Monetary Policy Transmission**:
   - **US monetary policy** impacts **global economy**: *asset prices*, *bank lending*, *capital flows*, etc.

   $\Rightarrow$ Why are some **countries affected** more by **US monetary policy** than others?

   $\Rightarrow$ **Exchange rates** are pivotal in **transmitting monetary policy** across countries.

2. **FX Factor Structure**:
   - Lustig, Roussanov, and Verdelhan (2011), Verdelhan (2018): **dollar** and **carry**

$$\Delta FX_{i,t} = \alpha + \beta_i^{DOL} Dollar_t + \beta_i^{CAR} Carry_t + \epsilon_{i,t}$$

   - Chernov, Dahlquist, and Lochstoer (2023): unconditional mean-variance portfolio (**UMVE**)

$$\Delta FX_{i,t} = \alpha + \beta_i^{UMVE} UMVE_t + \epsilon_{i,t}$$

Q: Can the **exposure** to these **factors** (betas) explain the **cross-sectional differences**?

Motivation: US Monetary Policy and FX Factor Structure

1. **US Monetary Policy Transmission**:
   - **US monetary policy** impacts **global economy**: *asset prices*, *bank lending*, *capital flows*, etc.

   $\Rightarrow$ Why are some **countries affected** more by **US monetary policy** than others?

   $\Rightarrow$ **Exchange rates** are pivotal in **transmitting monetary policy** across countries.

2. **FX Factor Structure**:
   - Lustig, Roussanov, and Verdelhan (2011), Verdelhan (2018): **dollar** and **carry**

$$\Delta FX_{i,t} = \alpha + \beta_i^{DOL} Dollar_t + \beta_i^{CAR} Carry_t + \epsilon_{i,t}$$

   - Chernov, Dahlquist, and Lochstoer (2023): unconditional mean-variance portfolio (**UMVE**)

$$\Delta FX_{i,t} = \alpha + \beta_i^{UMVE} UMVE_t + \epsilon_{i,t}$$

Q: Can the **exposure** to these **factors** (betas) explain the **cross-sectional differences**?

Main Result

FX factor structure explains **international transmission** of **US monetary policy** to:

1. **Global Currency Flows** (CLS settlement data)
   - **Funds buy high-risk** and **sell low-risk** currencies after US monetary policy eases.
   - **Persistent effect: high-risk** currencies face **lasting demand** for several months.
2. **International Bank Lending** (DealScan syndicated loans)
   - Identify **globally active US banks** that **lend** in **foreign currencies** via syndicated loans.
   - **Banks** tilt **loan origination** from **low-** to **high-risk** currencies as monetary policy eases.
3. **Firm-level Outcomes** (Compustat global + NA)
   - **Firms** exposed to **high-risk currencies borrow** more as US monetary policy eases.
   - **High-risk currency borrowers** increase their **investment** relative to **low-risk borrowers**.

Main Result

FX factor structure explains **international transmission** of **US monetary policy** to:

1. **Global Currency Flows** (CLS settlement data)
   - **Funds buy high-risk** and **sell low-risk** currencies after US monetary policy eases.
   - **Persistent effect: high-risk** currencies face **lasting demand** for several months.
2. **International Bank Lending** (DealScan syndicated loans)
   - Identify **globally active US banks** that **lend** in **foreign currencies** via syndicated loans.
   - **Banks** tilt **loan origination** from **low-** to **high-risk** currencies as monetary policy eases.
3. **Firm-level Outcomes** (Compustat global + NA)
   - **Firms** exposed to **high-risk currencies borrow** more as US monetary policy eases.
   - **High-risk currency borrowers** increase their **investment** relative to **low-risk borrowers**.

Main Result

FX factor structure explains **international transmission** of **US monetary policy** to:

1. **Global Currency Flows** (CLS settlement data)
   - **Funds buy high-risk** and **sell low-risk** currencies after US monetary policy eases.
   - **Persistent effect: high-risk** currencies face **lasting demand** for several months.
2. **International Bank Lending** (DealScan syndicated loans)
   - Identify **globally active US banks** that **lend** in **foreign currencies** via syndicated loans.
   - **Banks** tilt **loan origination** from **low-** to **high-risk** currencies as monetary policy eases.
3. **Firm-level Outcomes** (Compustat global + NA)
   - **Firms** exposed to **high-risk currencies borrow** more as US monetary policy eases.
   - **High-risk currency borrowers** increase their **investment** relative to **low-risk borrowers**.

Main Result

FX factor structure explains **international transmission** of **US monetary policy** to:

1. **Global Currency Flows** (CLS settlement data)
   - **Funds buy high-risk** and **sell low-risk** currencies after US monetary policy eases.
   - **Persistent effect: high-risk** currencies face **lasting demand** for several months.
2. **International Bank Lending** (DealScan syndicated loans)
   - Identify **globally active US banks** that **lend** in **foreign currencies** via syndicated loans.
   - **Banks** tilt **loan origination** from **low-** to **high-risk** currencies as monetary policy eases.
3. **Firm-level Outcomes** (Compustat global + NA)
   - **Firms** exposed to **high-risk currencies borrow** more as US monetary policy eases.
   - **High-risk currency borrowers** increase their **investment** relative to **low-risk borrowers**.

(1) US Monetary Policy and Global Currency Flows

1. **How do currency flows respond to monetary policy surprises?**

$$\text{Spot Flow}_{ij,t} = a_{ij} + \beta_{ij} MPS_t + \epsilon_{ij,t}.$$

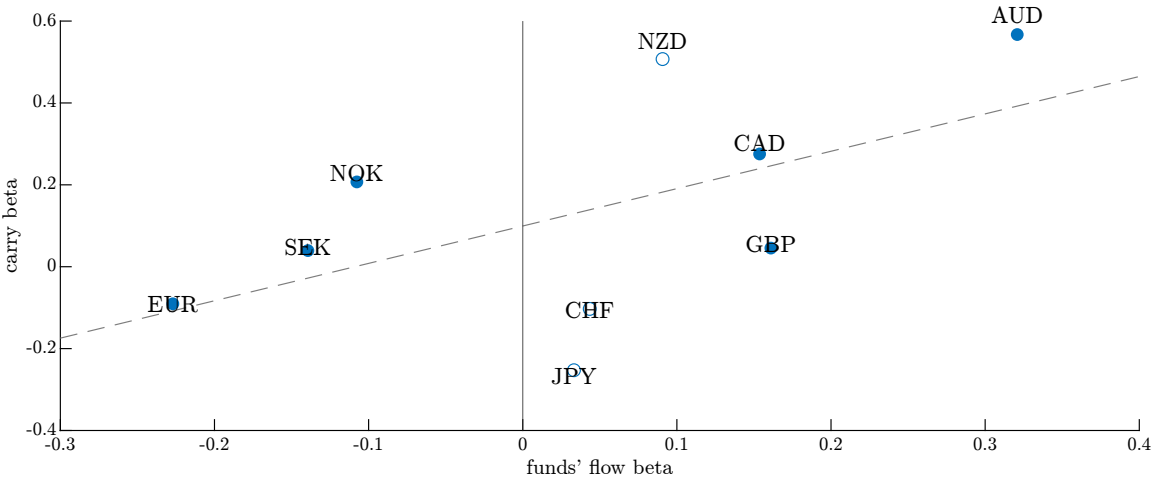
- $Spot\ Flow_{ij,t}$ is the spot flow into foreign currency i by investor group j within month t.
- MPS_t is our monetary policy surprise measure (Bernanke and Kuttner, 2005).
- **Monetary policy easing** $\Rightarrow$ higher willingness to take on risk (e.g., Bruno and Shin, 2015).

2. **Do FX factor exposures explain the heterogeneity in responses?**

$$\text{Spot Flow}_{i,t} = \mu_i + \alpha_t + \gamma X_{i,t} + \beta MPS_t + \varphi (X_{i,t} \times MPS_t) + \kappa \mathbf{W}_{i,t} + \epsilon_{i,t}.$$

- Focus on **investment funds** as their **flow betas** line up with **carry** and **UMVE betas**.
- $X_{i,t}$ is a measure of currency risk (e.g., **dollar**, **carry**, or **UMVE beta**).
- μ_i and α_t are currency- and time-fixed effects and $\mathbf{W}_{i,t}$ includes additional controls.

(1) Funds are Risk-On: Buy High-Risk, Sell Low-Risk Currencies



Note: Filled dots indicate statistical significance at the 10% confidence level. The inference is based on robust standard errors (Newey and West, 1987). The sample covers the period from September 2012 to March 2024.

(1) US Monetary Policy and Global Currency Flows

1. **How do currency flows respond to monetary policy surprises?**

$$\text{Spot Flow}_{ij,t} = a_{ij} + \beta_{ij} MPS_t + \epsilon_{ij,t}.$$

- $Spot\ Flow_{ij,t}$ is the spot flow into foreign currency i by investor group j within month t.
- MPS_t is our monetary policy shock measure (Bernanke and Kuttner, 2005).
- **Monetary policy easing** $\Rightarrow$ higher willingness to take on risk (e.g., Bruno and Shin, 2015).

2. **Do FX factor exposures explain the heterogeneity in responses?**

$$\text{Spot Flow}_{i,t} = \mu_i + \alpha_t + \gamma X_{i,t} + \beta MPS_t + \varphi (X_{i,t} \times MPS_t) + \kappa \mathbf{W}_{i,t} + \epsilon_{i,t}.$$

- Focus on **investment funds** as their **flow betas** line up with **carry** and **UMVE betas**.
- $X_{i,t}$ is a measure of currency risk (e.g., **dollar**, **carry**, or **UMVE beta**).
- μ_i and α_t are currency- and time-fixed effects and $\mathbf{W}_{i,t}$ includes additional controls.

(1) Heterogeneous Response of Funds' Spot Currency Flows

Dep. variable: Spot Flow$_{i,t}$	(1)	(2)	(3)	(4)	(5)
carry beta$_{i,t}$					
dollar beta$_{i,t}$					
UMVE beta$_{i,t}$					
MPS$_t$	0.03				
	[0.86]				
carry beta$_{i,t}$ × MPS$_t$					
dollar beta$_{i,t}$ × MPS$_t$					
UMVE beta$_{i,t}$ × MPS$_t$					
Overall R^2 in %	18.76				
Controls	yes				
Avg. #Time periods	139				
#Currencies	9				
Currency FE	yes				
Time series FE	no				

Note: Both dependent and independent variables are standardized. Inference is based on double clustered standard errors (by currencies and time). The CLS settlement data cover the period from September 2012 to March 2024.

(1) Heterogeneous Response of Funds' Spot Currency Flows

Dep. variable: Spot Flow$_{i,t}$	(1)	(2)	(3)	(4)	(5)
carry beta$_{i,t}$		0.00			
		[0.02]			
dollar beta$_{i,t}$			0.14		
			[0.76]		
UMVE beta$_{i,t}$					
MPS$_t$	0.03				
	[0.86]				
carry beta$_{i,t}$ × MPS$_t$		0.09***			
		[2.62]			
dollar beta$_{i,t}$ × MPS$_t$			0.07		
			[0.95]		
UMVE beta$_{i,t}$ × MPS$_t$					
Overall R^2 in %	18.76	30.80	30.65		
Controls	yes	yes	yes		
Avg. #Time periods	139	138	138		
#Currencies	9	9	9		
Currency FE	yes	yes	yes		
Time series FE	no	yes	yes		

Note: Both dependent and independent variables are standardized. Inference is based on double clustered standard errors (by currencies and time). The CLS settlement data cover the period from September 2012 to March 2024.

(1) Heterogeneous Response of Funds' Spot Currency Flows

Dep. variable: Spot Flow$_{i,t}$	(1)	(2)	(3)	(4)	(5)
carry beta$_{i,t}$		0.00		−0.15	
		[0.02]		[1.00]	
dollar beta$_{i,t}$			0.14	0.20	
			[0.76]	[0.95]	
UMVE beta$_{i,t}$					−0.17
					[1.33]
MPS$_t$	0.03				
	[0.86]				
carry beta$_{i,t}$ × MPS$_t$		0.09***		0.17***	
		[2.62]		[4.21]	
dollar beta$_{i,t}$ × MPS$_t$			0.07	−0.36***	
			[0.95]	[3.68]	
UMVE beta$_{i,t}$ × MPS$_t$					0.09***
					[4.21]
Overall R^2 in %	18.76	30.80	30.65	31.85	31.71
Controls	yes	yes	yes	yes	yes
Avg. #Time periods	139	138	138	138	138
#Currencies	9	9	9	9	9
Currency FE	yes	yes	yes	yes	yes
Time series FE	no	yes	yes	yes	yes

Note: Both dependent and independent variables are standardized. Inference is based on double clustered standard errors (by currencies and time). The CLS settlement data cover the period from September 2012 to March 2024.

(2) US Monetary Policy and International Bank Lending

So far: focus on how **dealer banks'** **customers** trade around **monetary policy surprises**.

Now: study the **risk-taking behavior** of **US banks** in **foreign currency lending**.

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

- $\log Loan_{i,t}$ is the log loan amount from **global US banks** (either BHC or subsidiary HQ in US) to firms domiciled abroad in foreign currency i during month t.
- $X_{i,t}$ is a measure of currency risk (e.g., **dollar**, **carry**, or **UMVE** beta).
- μ_i and α_t are currency- and time-fixed effects and $S_{i,t}$ is the dollar exchange rate.

(2) US Monetary Policy and International Bank Lending

So far: focus on how **dealer banks'** **customers** trade around **monetary policy surprises**.

Now: study the **risk-taking behavior** of **US banks** in **foreign currency lending**.

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

- $\log Loan_{i,t}$ is the log loan amount from **global US banks** (either BHC or subsidiary HQ in US) to firms domiciled abroad in foreign currency i during month t.
- $X_{i,t}$ is a measure of currency risk (e.g., **dollar**, **carry**, or **UMVE** beta).
- μ_i and α_t are currency- and time-fixed effects and $S_{i,t}$ is the dollar exchange rate.

(2) US Monetary Policy and International Bank Lending

So far: focus on how **dealer banks'** **customers** trade around **monetary policy surprises**.

Now: study the **risk-taking behavior** of **US banks** in **foreign currency lending**.

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

- $\log Loan_{i,t}$ is the log loan amount from **global US banks** (either BHC or subsidiary HQ in US) to firms domiciled abroad in foreign currency i during month t.
- $X_{i,t}$ is a measure of currency risk (e.g., **dollar**, **carry**, or **UMVE** beta).
- μ_i and α_t are currency- and time-fixed effects and $S_{i,t}$ is the dollar exchange rate.

(2) US Monetary Policy and International Bank Lending

So far: focus on how **dealer banks'** **customers** trade around **monetary policy surprises**.

Now: study the **risk-taking behavior** of **US banks** in **foreign currency lending**.

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

- $\log Loan_{i,t}$ is the log loan amount from **global US banks** (either BHC or subsidiary HQ in US) to firms domiciled abroad in foreign currency i during month t.
- $X_{i,t}$ is a measure of currency risk (e.g., **dollar**, **carry**, or **UMVE** beta).
- μ_i and α_t are currency- and time-fixed effects and $S_{i,t}$ is the dollar exchange rate.

(2) US Monetary Policy and International Bank Lending

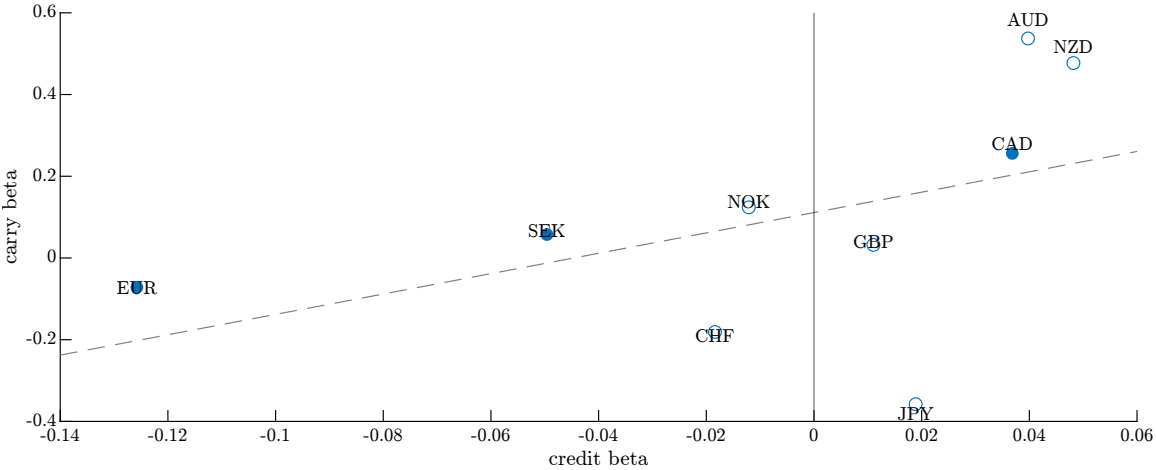
So far: focus on how **dealer banks'** **customers** trade around **monetary policy surprises**.

Now: study the **risk-taking behavior** of **US banks** in **foreign currency lending**.

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

- $\log Loan_{i,t}$ is the log loan amount from **global US banks** (either BHC or subsidiary HQ in US) to firms domiciled abroad in foreign currency i during month t.
- $X_{i,t}$ is a measure of currency risk (e.g., **dollar**, **carry**, or **UMVE** beta).
- μ_i and α_t are currency- and time-fixed effects and $S_{i,t}$ is the dollar exchange rate.

(2) Global US Banks are Risk-On in Foreign Currency Lending



Note: Filled dots indicate statistical significance at the 10% confidence level. The inference is based on robust standard errors (Newey and West, 1987). The sample covers the period from January 2000 to March 2024.

(2) Heterogeneous Response of Banks' Foreign Currency Lending

Dep. variable: log $Loan_{i,t}$	(1)	(2)	(3)	(4)	(5)
carry $beta_{i,t}$					
dollar $beta_{i,t}$					
UMVE $beta_{i,t}$					
MPS_t	0.03				
	[0.52]				
carry $beta_{i,t} \times MPS_t$					
dollar $beta_{i,t} \times MPS_t$					
UMVE $beta_{i,t} \times MPS_t$					
$\Delta \log S_{i,t}$	−0.08				
	[0.71]				
Overall R^2 in %	57.95				
Avg. #Time periods	291				
#Currencies	9				
Currency FE	yes				
Time series FE	no				

Note: The independent variables are measured in units of standard deviations. Inference is based on double clustered standard errors (by currencies and time). The DealScan sample spans from January 2000 to March 2024.

(2) Heterogeneous Response of Banks' Foreign Currency Lending

Dep. variable: log $Loan_{i,t}$	(1)	(2)	(3)	(4)	(5)
carry $beta_{i,t}$		−0.69			
		[1.59]			
dollar $beta_{i,t}$			0.41		
			[1.21]		
UMVE $beta_{i,t}$					
MPS_t	0.03				
	[0.52]				
carry $beta_{i,t} \times MPS_t$		0.11***			
		[2.65]			
dollar $beta_{i,t} \times MPS_t$			−0.49**		
			[2.13]		
UMVE $beta_{i,t} \times MPS_t$					
$\Delta \log S_{i,t}$	−0.08	−0.06	−0.08		
	[0.71]	[0.36]	[0.43]		
Overall R^2 in %	57.95	63.00	62.99		
Avg. #Time periods	291	291	291		
#Currencies	9	9	9		
Currency FE	yes	yes	yes		
Time series FE	no	yes	yes		

Note: The independent variables are measured in units of standard deviations. Inference is based on double clustered standard errors (by currencies and time). The DealScan sample spans from January 2000 to March 2024.

(2) Heterogeneous Response of Banks' Foreign Currency Lending

Dep. variable: log $Loan_{i,t}$	(1)	(2)	(3)	(4)	(5)
carry $beta_{i,t}$		−0.69		−1.37	
		[1.59]		[1.44]	
dollar $beta_{i,t}$			0.41	0.84	
			[1.21]	[1.24]	
UMVE $beta_{i,t}$					0.03
					[0.10]
MPS_t	0.03				
	[0.52]				
carry $beta_{i,t} \times MPS_t$		0.11***		0.17***	
		[2.65]		[3.01]	
dollar $beta_{i,t} \times MPS_t$			−0.49**	−0.68**	
			[2.13]	[2.14]	
UMVE $beta_{i,t} \times MPS_t$					0.18**
					[2.07]
$\Delta \log S_{i,t}$	−0.08	−0.06	−0.08	−0.07	−0.05
	[0.71]	[0.36]	[0.43]	[0.43]	[0.26]
Overall R^2 in %	57.95	63.00	62.99	63.21	62.93
Avg. #Time periods	291	291	291	291	291
#Currencies	9	9	9	9	9
Currency FE	yes	yes	yes	yes	yes
Time series FE	no	yes	yes	yes	yes

Note: The independent variables are measured in units of standard deviations. Inference is based on double clustered standard errors (by currencies and time). The DealScan sample spans from January 2000 to March 2024.

(3) US Monetary Policy and Firm-level Outcomes

So far: focus on **heterogeneous response** of **foreign currency lending** by **global US banks** to changes in **US monetary policy** conditional on measures of currency risk.

Now: study the **real economic effects** of these **loan supply shocks** on the cross-section of **international firms** borrowing from **global US banks**.

Goal: show that **firms exposed** to **low-** vs **high-risk currencies** are affected differently.

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

- $Loan_{j,i,c,t}$ is the total cumulative dollar amount that firm j in country c has borrowed from global US banks in currency i via syndicated loans in quarter t.
- $X_{i,t}$ is assigned to firm j based on their **reporting currency** i.
- μ_j and $\alpha_{c,t}$ are **firm-** and **country-time-fixed effects** controlling for global factors.

(3) US Monetary Policy and Firm-level Outcomes

So far: focus on **heterogeneous response** of **foreign currency lending** by **global US banks** to changes in **US monetary policy** conditional on measures of currency risk.

Now: study the **real economic effects** of these **loan supply shocks** on the cross-section of **international firms** borrowing from **global US banks**.

Goal: show that **firms exposed** to **low-** vs **high-risk currencies** are affected differently.

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

- $Loan_{j,i,c,t}$ is the total cumulative dollar amount that firm j in country c has borrowed from global US banks in currency i via syndicated loans in quarter t.
- $X_{i,t}$ is assigned to firm j based on their **reporting currency** i.
- μ_j and $\alpha_{c,t}$ are **firm-** and **country-time-fixed effects** controlling for global factors.

(3) US Monetary Policy and Firm-level Outcomes

So far: focus on **heterogeneous response** of **foreign currency lending** by **global US banks** to changes in **US monetary policy** conditional on measures of currency risk.

Now: study the **real economic effects** of these **loan supply shocks** on the cross-section of **international firms** borrowing from **global US banks**.

Goal: show that **firms exposed** to **low-** vs **high-risk currencies** are affected differently.

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

- $Loan_{j,i,c,t}$ is the total cumulative dollar amount that firm j in country c has borrowed from global US banks in currency i via syndicated loans in quarter t.
- $X_{i,t}$ is assigned to firm j based on their **reporting currency** i.
- μ_j and $\alpha_{c,t}$ are **firm-** and **country-time-fixed effects** controlling for global factors.

(3) US Monetary Policy and Firm-level Outcomes

So far: focus on **heterogeneous response** of **foreign currency lending** by **global US banks** to changes in **US monetary policy** conditional on measures of currency risk.

Now: study the **real economic effects** of these **loan supply shocks** on the cross-section of **international firms** borrowing from **global US banks**.

Goal: show that **firms exposed** to **low-** vs **high-risk currencies** are affected differently.

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

- $Loan_{j,i,c,t}$ is the total cumulative dollar amount that firm j in country c has borrowed from global US banks in currency i via syndicated loans in quarter t.
- $X_{i,t}$ is assigned to firm j based on their **reporting currency** i.
- μ_j and $\alpha_{c,t}$ are **firm-** and **country-time-fixed effects** controlling for global factors.

(3) US Monetary Policy and Firm-level Outcomes

So far: focus on **heterogeneous response** of **foreign currency lending** by **global US banks** to changes in **US monetary policy** conditional on measures of currency risk.

Now: study the **real economic effects** of these **loan supply shocks** on the cross-section of **international firms** borrowing from **global US banks**.

Goal: show that **firms exposed** to **low-** vs **high-risk currencies** are affected differently.

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

- $Loan_{j,i,c,t}$ is the total cumulative dollar amount that firm j in country c has borrowed from global US banks in currency i via syndicated loans in quarter t.
- $X_{i,t}$ is assigned to firm j based on their **reporting currency** i.
- μ_j and $\alpha_{c,t}$ are **firm-** and **country-time-fixed effects** controlling for global factors.

(3) US Monetary Policy and Firm-level Outcomes

So far: focus on **heterogeneous response** of **foreign currency lending** by **global US banks** to changes in **US monetary policy** conditional on measures of currency risk.

Now: study the **real economic effects** of these **loan supply shocks** on the cross-section of **international firms** borrowing from **global US banks**.

Goal: show that **firms exposed** to **low-** vs **high-risk currencies** are affected differently.

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

- $Loan_{j,i,c,t}$ is the total cumulative dollar amount that firm j in country c has borrowed from global US banks in currency i via syndicated loans in quarter t.
- $X_{i,t}$ is assigned to firm j based on their **reporting currency** i.
- μ_j and $\alpha_{c,t}$ are **firm-** and **country-time-fixed effects** controlling for global factors.

(3) Firms Exposed to Riskier Currencies Borrow More After Easing

Dep. variable: log $Loan_{j,i,c,t}$	(1)	(2)	(3)	(4)	(5)	(6)
carry $beta_{i,t}$	−0.05*		0.01			
	[1.78]		[0.47]			
dollar $beta_{i,t}$		−0.12***	−0.12***			
		[3.31]	[3.20]			
carry $beta_{i,t} \times MPS_t$	0.05***		0.05***			
	[3.33]		[2.93]			
dollar $beta_{i,t} \times MPS_t$		−0.11***	−0.09***			
		[3.54]	[3.88]			
log $S_{i,t}$	−0.21	−0.26*	−0.27*			
	[1.32]	[1.68]	[1.68]			
Overall R^2 in %	4.32	4.36	4.37			
Max #Time periods	95	95	95			
#Firms	1115	1115	1115			
Controls	yes	yes	yes			
Firm FE	yes	yes	yes			
Time series FE	yes	yes	yes			
Country × time FE	no	no	no			

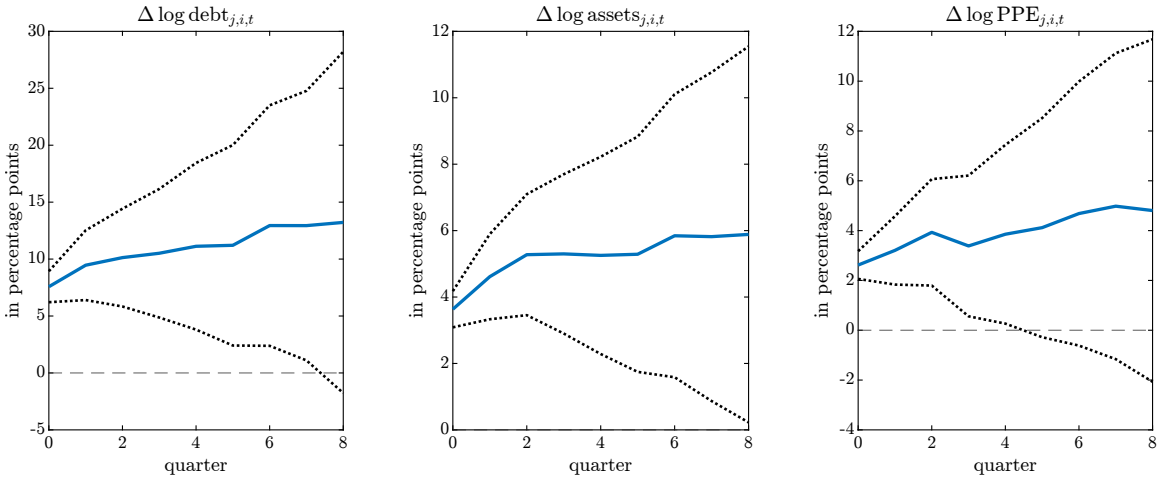
Note: The independent variables are measured in units of standard deviations. Inference is based on double clustered standard errors (by firms and time). The Compustat sample spans from January 2000 to March 2024.

(3) Firms Exposed to Riskier Currencies Borrow More After Easing

Dep. variable: log $Loan_{j,i,c,t}$	(1)	(2)	(3)	(4)	(5)	(6)
carry $beta_{i,t}$	−0.05*		0.01	−0.13***		−0.08***
	[1.78]		[0.47]	[6.71]		[13.92]
dollar $beta_{i,t}$		−0.12***	−0.12***		−0.23***	−0.20***
		[3.31]	[3.20]		[3.92]	[3.66]
carry $beta_{i,t} \times MPS_t$	0.05***		0.05***	0.20**		0.18**
	[3.33]		[2.93]	[2.31]		[2.28]
dollar $beta_{i,t} \times MPS_t$		−0.11***	−0.09***		0.04	0.06*
		[3.54]	[3.88]		[1.15]	[1.71]
log $S_{i,t}$	−0.21	−0.26*	−0.27*	−0.39***	−0.47***	−0.50***
	[1.32]	[1.68]	[1.68]	[3.81]	[2.91]	[2.95]
Overall R^2 in %	4.32	4.36	4.37	3.84	3.84	3.86
Max #Time periods	95	95	95	95	95	95
#Firms	1115	1115	1115	1115	1115	1115
Controls	yes	yes	yes	yes	yes	yes
Firm FE	yes	yes	yes	yes	yes	yes
Time series FE	yes	yes	yes	no	no	no
Country × time FE	no	no	no	yes	yes	yes

Note: The independent variables are measured in units of standard deviations. Inference is based on double clustered standard errors (by firms and time). The Compustat sample spans from January 2000 to March 2024.

(3) Borrowing Firms Increase Leverage, Assets, and Investment



Note: This figure plots cumulative impulse responses of firm-level variables. The dotted lines mark the 90% confidence bands based on Newey and West (1987) standard errors. The sample spans from January 2000 to March 2024.

Conclusion

⇒ Following an unexpected **easing** of **US monetary policy**

1. **Funds buy high-risk** and **sell low-risk** currencies.
2. **Banks lend more** in **high-** vs **low-risk** currencies.
3. **Firms** exposed to **high-risk** currencies **invest** more.

⇒ Exposures to **currency risk** (i.e., **dollar**, **carry**, **UMVE** betas) successfully explain the **cross-sectional differences** in how **quantities respond** to US monetary policy.

Thank you!!

Conclusion

⇒ Following an unexpected **easing** of **US monetary policy**

1. **Funds buy high-risk** and **sell low-risk** currencies.
2. **Banks lend more** in **high-** vs **low-risk** currencies.
3. **Firms** exposed to **high-risk** currencies **invest** more.

⇒ Exposures to **currency risk** (i.e., **dollar**, **carry**, **UMVE** betas) successfully explain the **cross-sectional differences** in how **quantities respond** to US monetary policy.

Thank you!!

Conclusion

⇒ Following an unexpected **easing** of **US monetary policy**

1. **Funds buy high-risk** and **sell low-risk** currencies.
2. **Banks lend more** in **high-** vs **low-risk** currencies.
3. **Firms** exposed to **high-risk** currencies **invest** more.

⇒ Exposures to **currency risk** (i.e., **dollar**, **carry**, **UMVE** betas) successfully explain the **cross-sectional differences** in how **quantities respond** to US monetary policy.

Thank you!!

Appendix

Related Literature

International Asset Pricing

Interest parity deviations: e.g. Lustig and Verdelhan (2007), Lustig et al. (2011), Verdelhan (2018), Liu, Maurer, Vedolin, and Zhang (2022), Nucera, Sarno, and Zinna (2023)

Monetary policy impact: e.g. Eichenbaum and Evans (1995), Stavrakeva and Tang (2015), Schmitt-Grohé and Uribe (2018), Savor and Wilson (2014), Mueller, Tahbaz-Salehi, and Vedolin (2017), Ai and Bansal (2018), Antolin-Diaz, Cenedese, Han, and Sarno (2023), Roussanov and Wang (2023)

⇒ **This paper**: shows that the currency factor structure has implications for global currency flows.

Monetary Policy Transmission

Real economic effects: e.g. Ottonello and Winberry (2020), Bräuning and Ivashina (2020a,b), Zhang (2021), Correa, Paligorova, Sapriza, and Zlate (2021)

Global financial cycle: e.g. Rey (2013), Miranda-Agrippino and Rey (2020), Borio and Zhu (2012), Bruno and Shin (2015, 2017), Adrian, Estrella, and Shin (2019), Bauer, Bernanke, and Milstein (2023)

⇒ **This paper**: connects exchange rate factor structure to real effects of monetary policy transmission.

Data Overview

Dependent variables:

1. **Global currency flows from CLS Group**: track flows by various customer groups.
2. **Syndicated loans from DealScan**: bank lending behavior across foreign currencies.
3. **Compustat Global from S&P**: international firms' foreign currency borrowing.

Independent variables:

1. **Exchange rates, forward contracts, and excess returns**: currency risk factors.
2. **Measures of systematic currency risk**: propagation of shocks across countries.
3. **US monetary policy shocks from Fed Fund futures**: capture surprise component.

Data Overview

Dependent variables:

1. **Global currency flows from CLS Group**: track flows by various customer groups.
2. **Syndicated loans from DealScan**: bank lending behavior across foreign currencies.
3. **Compustat Global from S&P**: international firms' foreign currency borrowing.

Independent variables:

1. **Exchange rates, forward contracts, and excess returns**: currency risk factors.
2. **Measures of systematic currency risk**: propagation of shocks across countries.
3. **US monetary policy shocks from Fed Fund futures**: capture surprise component.

Data Overview

Dependent variables:

1. **Global currency flows from CLS Group**: track flows by various customer groups.
2. **Syndicated loans from DealScan**: bank lending behavior across foreign currencies.
3. **Compustat Global from S&P**: international firms' foreign currency borrowing.

Independent variables:

1. **Exchange rates, forward contracts, and excess returns**: currency risk factors.
2. **Measures of systematic currency risk**: propagation of shocks across countries.
3. **US monetary policy shocks from Fed Fund futures**: capture surprise component.

Data Overview

Dependent variables:

1. **Global currency flows from CLS Group**: track flows by various customer groups.
2. **Syndicated loans from DealScan**: bank lending behavior across foreign currencies.
3. **Compustat Global from S&P**: international firms' foreign currency borrowing.

Independent variables:

1. **Exchange rates, forward contracts, and excess returns**: currency risk factors.
2. **Measures of systematic currency risk**: propagation of shocks across countries.
3. **US monetary policy shocks from Fed Fund futures**: capture surprise component.

Data Overview

Dependent variables:

1. **Global currency flows from CLS Group**: track flows by various customer groups.
2. **Syndicated loans from DealScan**: bank lending behavior across foreign currencies.
3. **Compustat Global from S&P**: international firms' foreign currency borrowing.

Independent variables:

1. **Exchange rates, forward contracts, and excess returns**: currency risk factors.
2. **Measures of systematic currency risk**: propagation of shocks across countries.
3. **US monetary policy shocks from Fed Fund futures**: capture surprise component.

Data Overview

Dependent variables:

1. **Global currency flows from CLS Group**: track flows by various customer groups.
2. **Syndicated loans from DealScan**: bank lending behavior across foreign currencies.
3. **Compustat Global from S&P**: international firms' foreign currency borrowing.

Independent variables:

1. **Exchange rates, forward contracts, and excess returns**: currency risk factors.
2. **Measures of systematic currency risk**: propagation of shocks across countries.
3. **US monetary policy shocks from Fed Fund futures**: capture surprise component.

Exchange Rates, Forward Contracts, and Excess Returns

⇒ **Exchange rates:**

- Spot mid, bid, and ask quotes from Bloomberg.
- All exchange rates are defined as foreign currency units per US dollar.

⇒ **Forward rates:**

- Forward rates are from Bloomberg for various maturities (1, 3, and 12 month) and are also defined as foreign currency units per US dollar (e.g., 1.51 AUD per USD).

⇒ **Excess returns:**

For each currency i, we define the currency excess return as:

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

- $F_{i,t-m,t}$ is the price of a forward contract m periods ago maturing at date t.
- $S_{i,t}$ is the spot price at time t expressed as foreign currency units per US dollar.

Exchange Rates, Forward Contracts, and Excess Returns

⇒ **Exchange rates:**

- Spot mid, bid, and ask quotes from Bloomberg.
- All exchange rates are defined as foreign currency units per US dollar.

⇒ **Forward rates:**

- Forward rates are from Bloomberg for various maturities (1, 3, and 12 month) and are also defined as foreign currency units per US dollar (e.g., 1.51 AUD per USD).

⇒ **Excess returns:**

For each currency i, we define the currency excess return as:

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

- $F_{i,t-m,t}$ is the price of a forward contract m periods ago maturing at date t.
- $S_{i,t}$ is the spot price at time t expressed as foreign currency units per US dollar.

Exchange Rates, Forward Contracts, and Excess Returns

⇒ **Exchange rates:**

- Spot mid, bid, and ask quotes from Bloomberg.
- All exchange rates are defined as foreign currency units per US dollar.

⇒ **Forward rates:**

- Forward rates are from Bloomberg for various maturities (1, 3, and 12 month) and are also defined as foreign currency units per US dollar (e.g., 1.51 AUD per USD).

⇒ **Excess returns:**

For each currency i, we define the currency excess return as:

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

- $F_{i,t-m,t}$ is the price of a forward contract m periods ago maturing at date t.
- $S_{i,t}$ is the spot price at time t expressed as foreign currency units per US dollar.

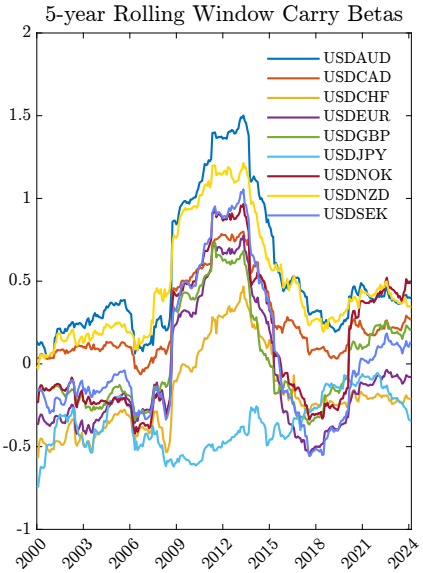
Systematic Currency Risk

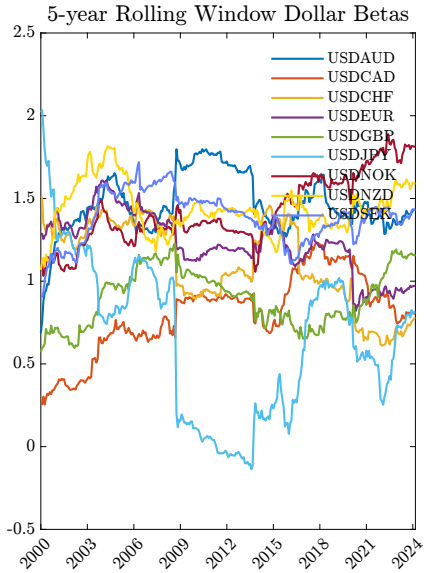
Measures of **systematic currency risk**:

$\Rightarrow$ Follow Verdelhan (2018) and estimate **FX factor model** using **rolling window**:

$$\Delta FX_{i,t} = \alpha + \beta_i^{DOL} Dollar_t + \epsilon_{i,t}$$
$$\Delta FX_{i,t} = \alpha + \beta_i^{CAR} Carry_t + \epsilon_{i,t}$$

$\Rightarrow$ **Dollar betas** β_i^{DOL} and **carry betas** β_i^{CAR} capture the **factor exposures**.





Note: This figure plots carry and dollar betas across G10 currency pairs that are based on 60-month rolling window regressions of currency excess returns on the carry and dollar factor, respectively.

Go back

Monetary Policy Surprises

- Follow Bernanke and Kuttner (2005) to measure the **monetary policy surprise** (MPS) on day t from changes in **Fed Fund futures** prices around FOMC announcements.
- **Positive values** correspond to an **easing surprise**.

We **time-aggregate** surprises as "Simple" and "Weighted" sums:

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

Note: The sample spans from 1 January 2000 to 29 March 2024. All shocks are in basis points (bps).

Monetary Policy Surprises

- Follow Bernanke and Kuttner (2005) to measure the **monetary policy surprise** (MPS) on day t from changes in **Fed Fund futures** prices around FOMC announcements.
- **Positive values** correspond to an **easing surprise**.

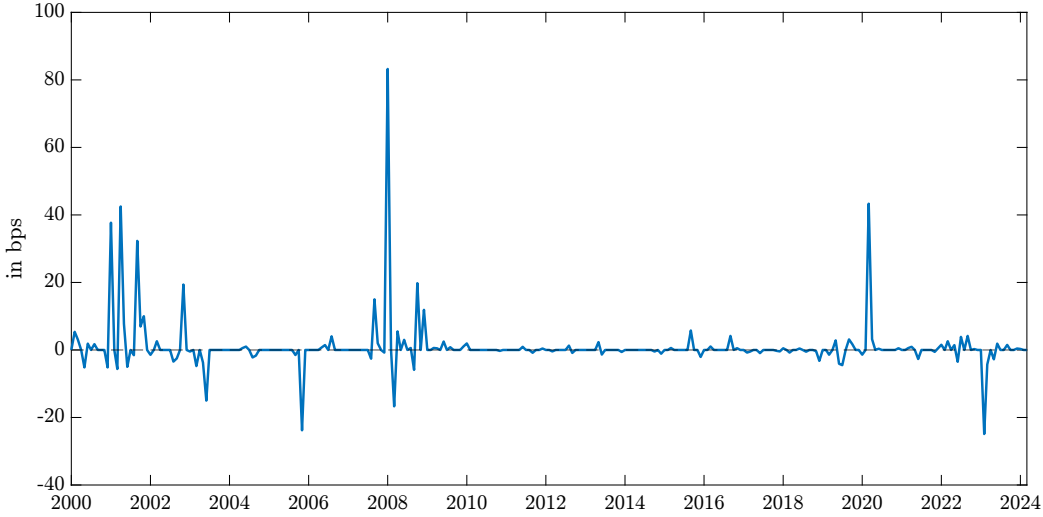
We **time-aggregate** surprises as "Simple" and "Weighted" sums:

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

Note: The sample spans from 1 January 2000 to 29 March 2024. All shocks are in basis points (bps).

Monetary Policy Surprises using Fed Fund Futures

Go back



Monetary Policy Surprises and Systematic Currency Risk

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

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

Example: USDEUR flows

Player	EUR buy volume (in USD)	EUR sell volume (in USD)	Order Flow
Corporates	100,294,116	11,070,887	89,223,229
Funds	48,540,172	717,368,707	(668,828,535)
Non-bank financials	57,996,743	149,442,298	(91,445,555)
Non-dealer banks	1,600,840,643	1,662,449,490	(61,608,847)
Total	1,807,671,674	2,540,331,382	(732,659,708)

Dealer banks	2,540,331,382	1,807,671,674	732,659,708

Reference Date: 01/02/2019 from 12 to 1pm GMT. USDEUR Spot = 0.88397

- **Dealers**: central position in the currency trading network.
- CLS uses network analysis to identify dealer banks in each currency pair.

Example: USDEUR flows

Player	EUR buy volume (in USD)	EUR sell volume (in USD)	Order Flow
Corporates	100,294,116	11,070,887	89,223,229
Funds	48,540,172	717,368,707	(668,828,535)
Non-bank financials	57,996,743	149,442,298	(91,445,555)
Non-dealer banks	1,600,840,643	1,662,449,490	(61,608,847)
Total	1,807,671,674	2,540,331,382	(732,659,708)

Dealer banks	2,540,331,382	1,807,671,674	732,659,708

Reference Date: 01/02/2019 from 12 to 1pm GMT. USDEUR Spot = 0.88397

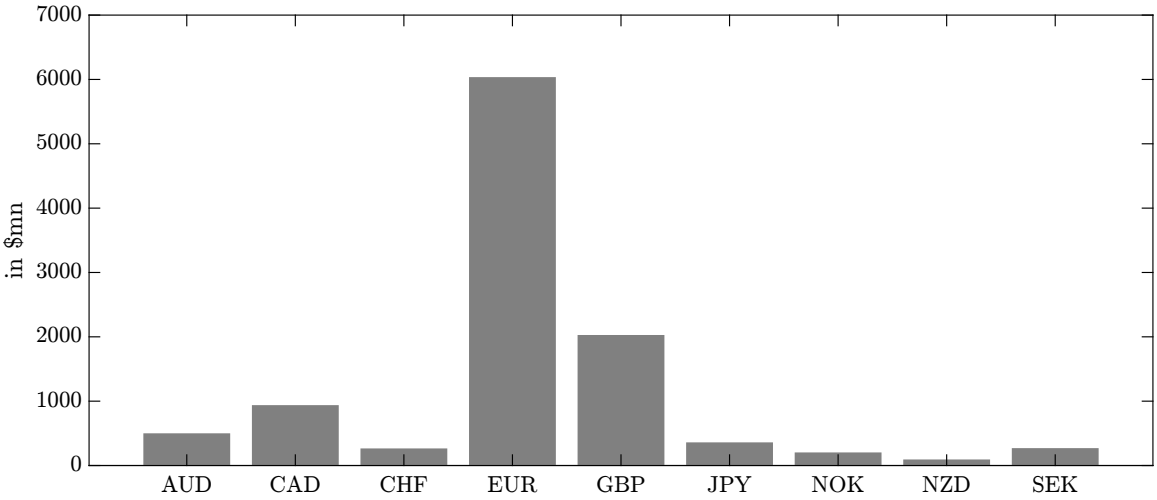
- **Dealers**: central position in the currency trading network.
- CLS uses network analysis to identify dealer banks in each currency pair.

Funds and Banks Dominate Global Currency Flows

	Corporates		Funds		NBFIs		Non-dealer banks	
	Std. in $bn	Share in %	Std. in $bn	Share in %	Std. in $bn	Share in %	Std. in $bn	Share in %
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: *Std.* reports the standard deviation of monthly buy minus sell volume, whereas *Share* sums up to 100% across groups and is based on the sum of buy and sell volume. The sample covers the period from September 2012 to March 2024.

Foreign Currency Lending is Concentrated in G10 Currencies



Note: Each bar shows the average monthly syndicated loan amount for the period from January 2000 to March 2024.

Monetary Policy Surprises and Global Currency Flows

⇒ How much do **currency flows** move in response to **changes** in **US monetary policy**?

⇒ Which **groups** of **market participants** are **driving** these **global currency flows**?

- **Corporates**: non-financial corporations (mostly large multinationals).
- **Funds**: mutual funds, pension funds, and high-frequency trading firms.
- **Non-bank financials**: insurance companies, brokers, and clearing houses.
- **Non-dealer banks**: banks that are not market makers in a specific currency.

⇒ Counterparties for each of these four groups are **dealer banks**.

Monetary Policy Surprises and Global Currency Flows

$\Rightarrow$ How much do **currency flows** move in response to **changes** in **US monetary policy**?

$\Rightarrow$ Which **groups** of **market participants** are **driving** these **global currency flows**?

- **Corporates**: non-financial corporations (mostly large multinationals).
- **Funds**: mutual funds, pension funds, and high-frequency trading firms.
- **Non-bank financials**: insurance companies, brokers, and clearing houses.
- **Non-dealer banks**: banks that are not market makers in a specific currency.

$\Rightarrow$ Counterparties for each of these four groups are **dealer banks**.

Monetary Policy Surprises and Global Currency Flows

⇒ How much do **currency flows** move in response to **changes** in **US monetary policy**?

⇒ Which **groups** of **market participants** are **driving** these **global currency flows**?

- **Corporates**: non-financial corporations (mostly large multinationals).
- **Funds**: mutual funds, pension funds, and high-frequency trading firms.
- **Non-bank financials**: insurance companies, brokers, and clearing houses.
- **Non-dealer banks**: banks that are not market makers in a specific currency.

⇒ Counterparties for each of these four groups are **dealer banks**.

Monetary Policy Surprises and Global Currency Flows

⇒ How much do **currency flows** move in response to **changes** in **US monetary policy**?

⇒ Which **groups** of **market participants** are **driving** these **global currency flows**?

- **Corporates**: non-financial corporations (mostly large multinationals).
- **Funds**: mutual funds, pension funds, and high-frequency trading firms.
- **Non-bank financials**: insurance companies, brokers, and clearing houses.
- **Non-dealer banks**: banks that are not market makers in a specific currency.

⇒ Counterparties for each of these four groups are **dealer banks**.

Monetary Policy Surprises and Global Currency Flows

⇒ How much do **currency flows** move in response to **changes** in **US monetary policy**?

⇒ Which **groups** of **market participants** are **driving** these **global currency flows**?

- **Corporates**: non-financial corporations (mostly large multinationals).
- **Funds**: mutual funds, pension funds, and high-frequency trading firms.
- **Non-bank financials**: insurance companies, brokers, and clearing houses.
- **Non-dealer banks**: banks that are not market makers in a specific currency.

⇒ Counterparties for each of these four groups are **dealer banks**.

Monetary Policy Surprises and Global Currency Flows

$\Rightarrow$ How much do **currency flows** move in response to **changes** in **US monetary policy**?

$\Rightarrow$ Which **groups** of **market participants** are **driving** these **global currency flows**?

- **Corporates**: non-financial corporations (mostly large multinationals).
- **Funds**: mutual funds, pension funds, and high-frequency trading firms.
- **Non-bank financials**: insurance companies, brokers, and clearing houses.
- **Non-dealer banks**: banks that are not market makers in a specific currency.

$\Rightarrow$ Counterparties for each of these four groups are **dealer banks**.

Flows by Funds and Banks Respond to US Monetary Policy

	Corporates	Funds	NBFIs	Non-dealer banks	Dealer banks	carry beta	dollar beta
USDJPY						−0.25	0.51
USDCHF						−0.10	0.98
USDEUR						−0.09	1.11
USDSEK						0.04	1.34
USDGBP						0.05	0.87
USDNOK						0.21	1.57
USDCAD						0.28	0.96
USDNZD						0.51	1.42
USDAUD						0.57	1.44

Note: Coefficients are in $mn. The numbers inside the brackets are the corresponding test statistics based on robust standard errors (Newey and West, 1987). The sample covers the period from September 2012 to March 2024.

Flows by Funds and Banks Respond to US Monetary Policy

	Corporates	Funds	NBFIs	Non-dealer banks	Dealer banks	carry beta	dollar beta
USDJPY	8.04	35.88	14.42			−0.25	0.51
	[0.56]	[0.74]	[1.03]				
USDCHF	7.08	23.51	−10.85			−0.10	0.98
	[0.76]	[0.42]	[0.67]				
USDEUR	31.47	−580.18***	16.15*			−0.09	1.11
	[0.95]	[4.57]	[1.86]				
USDSEK	4.17**	−30.21***	−2.18			0.04	1.34
	[2.54]	[3.14]	[1.38]				
USDGBP	−72.82***	210.39***	−25.46*			0.05	0.87
	[2.90]	[3.38]	[1.76]				
USDNOK	−4.39**	−13.99***	−1.19			0.21	1.57
	[2.12]	[3.33]	[1.15]				
USDCAD	2.18	537.22***	25.06			0.28	0.96
	[0.46]	[5.67]	[1.51]				
USDNZD	−1.67	23.94	1.32			0.51	1.42
	[1.59]	[1.13]	[1.55]				
USDAUD	−0.02	190.42***	1.03			0.57	1.44
	[0.00]	[5.23]	[0.20]				

Note: Coefficients are in $mn. The numbers inside the brackets are the corresponding test statistics based on robust standard errors (Newey and West, 1987). The sample covers the period from September 2012 to March 2024.

Flows by Funds and Banks Respond to US Monetary Policy

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

Note: Coefficients are in $mn. The numbers inside the brackets are the corresponding test statistics based on robust standard errors (Newey and West, 1987). The sample covers the period from September 2012 to March 2024.

Robustness and Additional Analyses

1. **Persistent effect of monetary policy**: investment funds' currency flows into high-risk currencies persist over several months. ▸ Details
2. **Economic sources of currency risk**: country-level risk characteristics. ▸ Table
3. **Expansionary and contractionary monetary policy**: expansions dominate. ▸ Figure
4. **Alternative story**: other central banks react systematically to US shocks. ▸ Table
5. **Other measures of monetary policy shocks**: target rate surprises dominate. ▸ Table
6. **European monetary policy shocks**: do not matter for euro-based currency flows. ▸ Table

Persistent Effect of Monetary Policy on Funds' Currency Flows

Are the effects of monetary policy on currency flows long-lasting or rather short-lived?

1. **Funds' forward currency flows:**

$$\text{Forward Flow}_{i,t,t+m} = \mu_i + \alpha_t + \gamma X_{i,t} + \beta MPS_t + \varphi (X_{i,t} \times MPS_t) + \kappa \mathbf{W}_{i,t} + \epsilon_{i,t,}$$

   - Replace **spot flow** with **forward flow** at maturities 1, 3, and 12 months.
   - MPS_t is our monetary policy shock following Bernanke and Kuttner (2005).

2. **Local projections (Jordà, 2005) of funds' spot currency flows:**

$$\text{Spot Flow}^{\$}_{i,t,t} = \alpha_t + \sum_{h=0}^{12} \beta_h MPS_{t-h} + \epsilon^{\$}_{i,t,t}$$

   - $\$$ot currency pairs into certain profitable trend or carry trades.
   - $\text{Spot Flow}^{\$}_{i,t,t}$ is the spot currency flow within group i observed in month t ahead of MPS_t.

Persistent Effect of Monetary Policy on Funds' Currency Flows

Are the effects of monetary policy on currency flows long-lasting or rather short-lived?

1. **Funds' forward currency flows:**

$$\text{Forward Flow}_{i,t+m} = \mu_i + \alpha_t + \gamma X_{i,t} + \beta MPS_t + \varphi\,(X_{i,t} \times MPS_t) + \kappa \mathbf{W}_{i,t} + \epsilon_{i,t}.$$

   - Replace **spot flow** with **forward flow** at maturities 1, 3, and 12 months.
   - MPS_t is our monetary policy shock following Bernanke and Kuttner (2005).

2. **Local projections (Jordà, 2005) of funds' spot currency flows:**

$$\text{Spot Flow}^{g}_{t,t+h} = \alpha^{g}_{h} + \sum_{m=0}^{3} \beta^{g}_{h,m} MPS_{t-m} + \epsilon^{g}_{t+h},$$

   - **Sort currency pairs** into **tertile portfolios** based on **carry betas**.
   - $\text{Spot Flow}^{g}_{t,t+h}$ is the spot currency flow within group g observed h months ahead of MPS_t.

Heterogeneous Response of Funds' Forward Currency Flows

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

Note: Both dependent and independent variables are standardized. Inference is based on double clustered standard errors (by currencies and time). The sample covers the period from September 2012 to March 2024.

Persistent Effect of Monetary Policy on Funds' Currency Flows

Are the effects of monetary policy on currency flows long-lasting or rather short-lived?

1. **Funds' forward currency flows:**

$$\text{Forward Flow}_{i,t+m} = \mu_i + \alpha_t + \gamma X_{i,t} + \beta MPS_t + \varphi(X_{i,t} \times MPS_t) + \kappa \mathbf{W}_{i,t} + \epsilon_{i,t}.$$

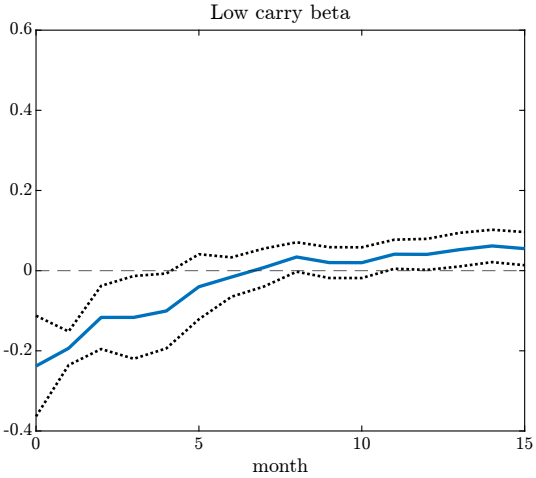
   - Replace **spot flow** with **forward flow** at maturities 1, 3, and 12 months.
   - MPS_t is our monetary policy shock following Bernanke and Kuttner (2005).

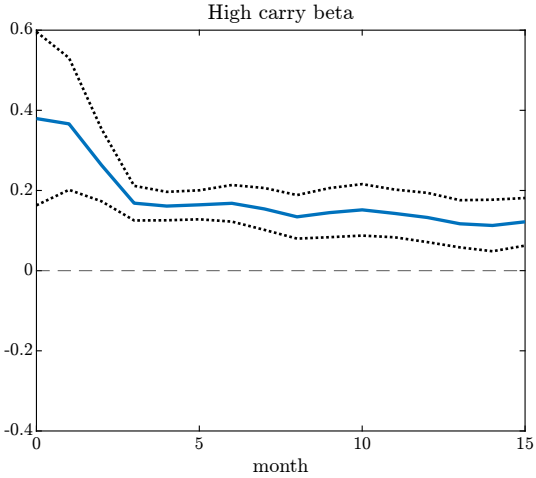
2. **Local projections (Jordà, 2005) of funds' spot currency flows:**

$$\text{Spot Flow}^g_{t,t+h} = \alpha^g_h + \sum_{m=0}^{3} \beta^g_{h,m} MPS_{t-m} + \epsilon^g_{t+h},$$

   - **Sort currency pairs** into **tertile portfolios** based on **carry betas**.
   - $\text{Spot Flow}^g_{t,t+h}$ is the spot currency flow within group g observed h months ahead of MPS_t.

Lasting Effect of Monetary Policy on Funds' Spot Currency Flows





Note: This figure plots cumulative impulse responses of flows to MP surprises. The dotted lines mark the 90% confidence bands using Newey and West (1987) standard errors. The sample spans from September 2012 to March 2024.

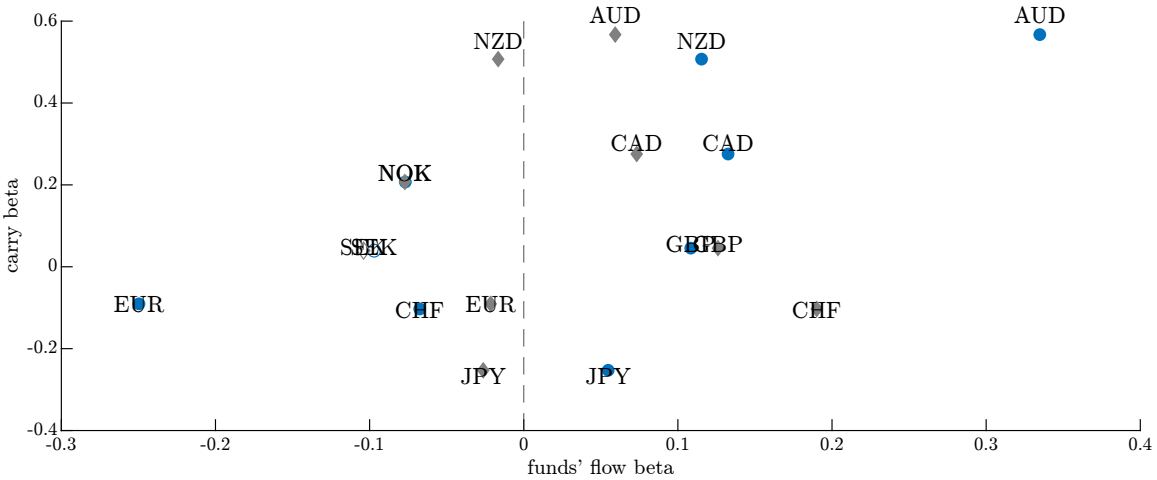
Go back

Currency Flows of Funds and a Horse Race of Currency Risks

Dep. variable: Spot Flow$_{i,t}$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
MPS$_t$	0.01	0.01	0.04	0.10**	−0.03	0.09**	0.12***	−0.03
	[0.26]	[1.01]	[1.11]	[2.07]	[0.46]	[2.06]	[2.83]	[1.17]
carry beta$_{i,t}$ × MPS$_t$	0.09***							
	[2.75]							
IMB beta$_{i,t}$ × MPS$_t$		−0.01						
		[0.51]						
downside beta$_{i,t}$ × MPS$_t$			0.01					
			[0.71]					
$f_{i,t} - s_{i,t}$ × MPS$_t$				0.09**				
				[2.01]				
centrality$_{i,t}$ × MPS$_t$					−0.08			
					[1.40]			
term premium$_{i,t}$ × MPS$_t$						0.09		
						[1.60]		
size$_{i,t}$ × MPS$_t$							−0.14***	
							[12.90]	
import ratio$_{i,t}$ × MPS$_t$								0.07***
								[4.52]
Overall R^2 in %	19.46	34.52	19.18	19.22	19.73	19.34	21.69	33.57
Avg. #Time periods	138	94	138	138	138	138	135	99
#Currencies	9	9	9	9	9	9	8	9
Currency FE	yes	yes	yes	yes	yes	yes	yes	yes

Note: Both dependent and independent variables are standardized. Inference is based on double clustered standard errors (by currencies and time). The sample covers the period from September 2012 to March 2024. Go back

US Monetary Policy Easing (Dots) and Tightening (Diamonds)



Note: Filled dots and diamonds indicate statistical significance at the 10% confidence level. The inference is based on robust standard errors (Newey and West, 1987). The sample spans from September 2012 to March 2024.

Go back

Predicting Foreign Policy Rates with Fed Fund Rates

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

Note: Both dependent and independent variables are standardized. Inference is based on double clustered standard errors (by currencies and time). The sample covers the period from January 2000 to March 2024. Go back

Fund Flows and a Horse Race of Monetary Policy Surprises

	Kuttner (2001)	Kearns, Schrimpf, and Xia, 2022			Jarociński and Karadi (2020)		Bauer and Swanson (2023)	
		Target	Path	Long-rate	MP	CBI	NS	ORT
carry beta$_{i,t}$	0.00	0.01	0.01	0.01	0.00	0.01	0.02	0.01
	[0.08]	[0.17]	[0.24]	[0.19]	[0.05]	[0.20]	[0.37]	[0.22]
dollar beta$_{i,t}$	0.12	0.10	0.10	0.11	0.11	0.11	0.11	0.10
	[0.65]	[0.60]	[0.61]	[0.64]	[0.66]	[0.65]	[0.65]	[0.61]
MPS$_t$	0.24**	−0.02	0.05*	−0.03	0.04	−0.01	0.03*	0.02
	[2.45]	[0.82]	[1.80]	[0.85]	[1.15]	[1.01]	[1.85]	[0.77]
carry beta$_{i,t}$ × MPS$_t$	0.14***	0.08**	−0.03*	−0.02	0.01	0.02	0.05	0.01**
	[3.79]	[2.29]	[1.77]	[0.58]	[0.64]	[0.59]	[1.34]	[2.46]
dollar beta$_{i,t}$ × MPS$_t$	−0.26***	0.03***	0.05	0.04	0.03	0.04	0.02	0.03
	[2.67]	[4.38]	[1.42]	[1.02]	[1.16]	[1.15]	[0.49]	[1.33]
Overall R^2 in %	20.08	20.62	20.36	20.21	20.27	20.12	20.61	20.51
Avg. #Time periods	138	137	137	137	137	137	136	129
#Currencies	9	9	9	9	9	9	9	9
Currency FE	yes	yes	yes	yes	yes	yes	yes	yes

Note: Both dependent and independent variables are standardized. Inference is based on double clustered standard errors (by currencies and time). The sample covers the period from September 2012 to March 2024. Go back

Bank Loans and a Horse Race of Monetary Policy Surprises

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

Note: The independent variables are measured in units of standard deviations. Inference is based on double clustered standard errors (by currencies and time). The sample spans from January 2000 to March 2024. Go back

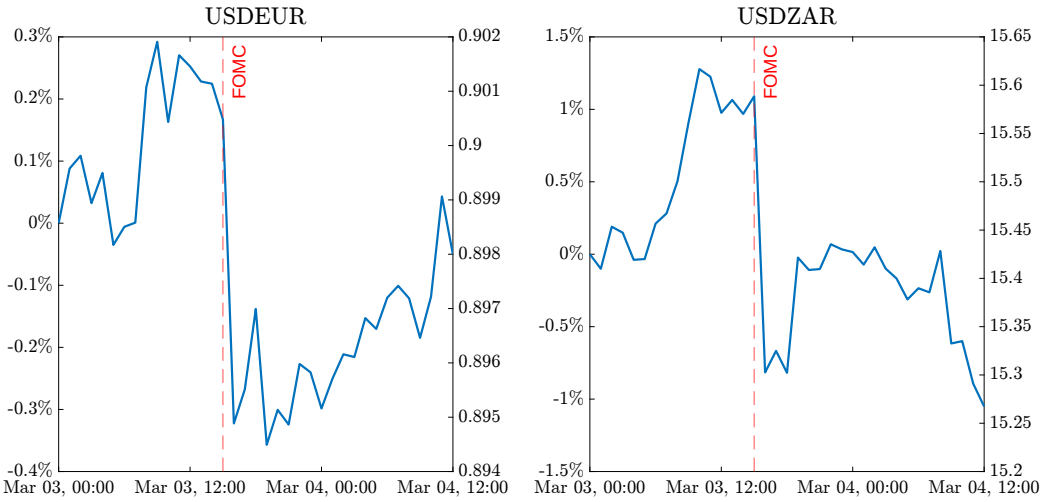
Flow Betas for Euro Currency Pairs

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

Note: Coefficients are in €mn. The numbers inside the brackets are the corresponding test statistics based on robust standard errors (Newey and West, 1987). The sample covers the period from September 2012 to October 2023.

Go back

US Monetary Policy and Exchange Rates



Note: On 3 March 2020 at 15:00 GMT the Fed cut interest rates unexpectedly by 50 bps.

Go back

References I

Adrian, T., Estrella, A., and Shin, H. S., 2019. Risk-taking channel of monetary policy. *Financial Management*, 48(3):725–738.

Ai, H. and Bansal, R., 2018. Risk preferences and the macroeconomic announcement premium. *Econometrica*, 86(4):1383–1430.

Antolin-Diaz, J., Cenedese, G., Han, S., and Sarno, L., 2023. US interest rate surprises and currency returns. *SSRN Electronic Journal*.

Bauer, M. D. and Swanson, E. T., 2023. A reassessment of monetary policy surprises and high-frequency identification. *NBER Macroeconomics Annual*, 37: 87–155.

Bauer, M. D., Bernanke, B. S., and Milstein, E., 2023. Risk appetite and the risk-taking channel of monetary policy. *Journal of Economic Perspectives*, 37(1): 77–100.

Bernanke, B. S. and Kuttner, K. N., 2005. What explains the stock market's reaction to Federal Reserve policy? *The Journal of Finance*, 60(3):1221–1257.

Borio, C. and Zhu, H., 2012. Capital regulation, risk-taking and monetary policy: A missing link in the tranmission mechanism? *Journal of Financial Stability*, 8 (4):236–251.

Bräuning, F. and Ivashina, V., 2020a. Monetary policy and global banking. *The Journal of Finance*, 75(6):3055–3095.

Bräuning, F. and Ivashina, V., 2020b. U.S. monetary policy and emerging market credit cycles. *Journal of Monetary Economics*, 112:57–76.

Bruno, V. and Shin, H. S., 2015. Capital flows and the risk-taking channel of monetary policy. *Journal of Monetary Economics*.

Bruno, V. and Shin, H. S., 2017. Global dollar credit and carry trades: A firm-level analysis. *The Review of Financial Studies*, 30(3):703–749.

Chernov, M., Dahlquist, M., and Lochstoer, L., 2023. Pricing currency risks. *The Journal of Finance*, 78(2):693–730.

Correa, R., Paligorova, T., Sapriza, H., and Zlate, A., 2021. Cross-border bank flows and monetary policy. *The Review of Financial Studies*, 35(1):438–481.

Eichenbaum, M. and Evans, C. L., 1995. Some empirical evidence on the effects of shocks to monetary policy on exchange rates. *Quarterly Journal of Economics*, 110(4):975–1009.

Jarociński, M. and Karadi, P., 2020. Deconstructing monetary policy surprises— the role of information shocks. *American Economic Journal: Macroeconomics*, 12 (2):1–43.

Jordà, Ò., 2005. Estimation and inference of impulse responses by local projections. *American Economic Review*, 95(1):161–182.

References II

Kearns, J., Schrimpf, A., and Xia, F. D., 2022. Explaining monetary spillovers: The matrix reloaded. *Journal of Money, Credit and Banking*, 55(6):1535–1568.

Kuttner, K., 2001. Monetary policy surprises and interest rates: Evidence from Fed Funds futures market. *Journal of Monetary Economics*, 47(3):523–544.

Liu, S., Maurer, T. A., Vedolin, A., and Zhang, Y., 2022. Dollar and carry redux. *SSRN Electronic Journal*.

Lustig, H. and Verdelhan, A., 2007. The cross section of foreign currency risk premia and consumption growth risk. *American Economic Review*, 97(1):89–117.

Lustig, H., Roussanov, N., and Verdelhan, A., 2011. Common risk factors in currency markets. *Review of Financial Studies*, 24(11):3731–3777.

Miranda-Agrippino, S. and Rey, H., 2020. U.S. monetary policy and the global financial cycle. *The Review of Economic Studies*, 87(6):2754–2776.

Mueller, P., Tahbaz-Salehi, A., and Vedolin, A., 2017. Exchange rates and monetary policy uncertainty. *The Journal of Finance*, 72(3):1213–1252.

Newey, W. K. and West, K. D., 1987. A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica*, 55(3): 703.

Nucera, F., Sarno, L., and Zinna, G., 2023. Currency risk premiums redux. *The Review of Financial Studies*, 37(2):356–408.

Ottonello, P. and Winberry, T., 2020. Financial heterogeneity and the investment channel of monetary policy. *Econometrica*, 88(6):2473–2502.

Rey, H., 2013. Dilemma not trilemma: the global cycle and monetary policy independence. *Proceedings - Economic Policy Symposium - Jackson Hole*.

Roussanov, N. and Wang, X., 2023. Following the Fed: Limits of arbitrage and the dollar. *National Bureau of Economic Research*.

Savor, P. and Wilson, M., 2014. Asset pricing: A tale of two days. *Journal of Financial Economics*, 113(2):171–201.

Schmitt-Grohé, S. and Uribe, M., 2018. How important are terms-of-trade shocks? *International Economic Review*, 59(1):85–111.

Stavrakeva, V. and Tang, J. Exchange rates and monetary policy. FRB of Boston Working Paper No. 15–16, 2015.

Verdelhan, A., 2018. The share of systematic variation in bilateral exchange rates. *The Journal of Finance*, 73(1):375–418.

Zhang, T., 2021. Monetary policy spillovers through invoicing currencies. *The Journal of Finance*, 77(1):129–161.