Monetary Policy Surprises and Asset Price Responses

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MIT Predoctoral RA Coding Challenge

Replication: Code and data at `https://github.com/Toba4366/MIT-Coding-Challenge`

Task 1: Data Preparation and Surprise Selection

(a) Exploration of Surprise Measures

The USMPD contains multiple surprise measures constructed from federal funds futures around FOMC announcements: MP1 (target rate surprise from current-month contracts), MP2 (path surprise from 3-month-ahead contracts), ED1–ED4 (Eurodollar-based surprises), and principal component measures. I focus on MP1 and STMT (statement surprise), where STMT is a principal component that aggregates information across short-rate instruments, capturing both target and forward-guidance news.

(b) Primary Measure: STMT

I use STMT as my baseline surprise measure for three reasons: (1) it summarizes both target rate changes and forward guidance in a single interpretable series; (2) it correlates highly with both MP1 ($\rho = 0.89$) and MP2 ($\rho = 0.73$), capturing multiple dimensions of monetary news (Figure 1); (3) it explains a larger share of Treasury yield variation than MP1 alone ($R^2 = 0.27$ vs. 0.14 for the 2-year yield). MP1 serves as a robustness measure focusing narrowly on target rate surprises.

(c) Data Merge

The sample covers 274 FOMC announcements from January 1994 to December 2024. I merge surprises with: (i) daily spot exchange rates for 8 currencies (AUD, CAD, CHF, EUR, GBP, JPY, MXN, NOK); (ii) Treasury par yields (2Y, 5Y, 10Y) from the U.S. Department of the

Treasury; (iii) breakeven inflation rates (5Y, 10Y) from FRED. Exchange rate returns are defined as $r_{i,t} = -\Delta \log(e_{i,t})$ where e is foreign currency per USD, so positive values indicate foreign appreciation. NFA/GDP data come from Lane and Milesi-Ferretti (2018), matched using lagged annual values to avoid reverse causality.

(d) Summary Statistics

Table 1 presents summary statistics. Both surprise measures have means near zero (consistent with market efficiency) with fat tails reflecting crisis-period announcements. STMT has standard deviation 3.68 bps, with range $[-26.4, +9.0]$ bps. Cross-country NFA/GDP varies substantially: Switzerland (+142% GDP) and Norway (+68%) are large creditors; Australia (−52%) and Mexico (−39%) are debtors.

Task 2: Asset Price Responses to Monetary Policy

I estimate currency- and asset-specific regressions:

$$\Delta y_{i,t} = \alpha_i + \beta_i \cdot \text{Surprise}_t + \varepsilon_{i,t} \tag{1}$$

All regressions use heteroskedasticity-robust (HC1) standard errors. This inference approach is maintained consistently throughout.

Treasury Yields

Table 2 reports Treasury yield responses. A 1 bp STMT surprise raises the 2-year yield by 1.06 bps ($t = 6.2$, $R^2 = 0.27$), with effects declining at longer maturities (0.51 bps for 10Y). The strong, significant responses validate the identification strategy: these surprises capture meaningful monetary policy news that moves the yield curve. Figure 2 visualizes this relationship.

Breakeven Inflation

Breakeven responses (Table 2) are negative: -0.42 bps for 5Y ($R^2 = 0.06$), -0.26 bps for 10Y ($R^2 = 0.04$). Hawkish surprises lower inflation expectations, consistent with standard New Keynesian transmission where tighter policy anchors future inflation. The 10Y effect is statistically significant ($t = -2.4$). The lower R^2 values relative to Treasury yields suggest that surprises primarily reflect real rate movements rather than inflation compensation.

Exchange Rates

Table 3 reports exchange rate responses. Coefficients are heterogeneous across currencies (ranging from −1.6 bps for JPY to +0.8 bps for MXN per 1 bp shock) and imprecisely estimated—none is individually significant at conventional levels. R^2 values are uniformly below 1%, indicating daily FX returns are dominated by non-monetary factors—this is typical in event-study designs, where a single macro-shock explains only a small fraction of daily asset price variation. Figure 4 visualizes the coefficient heterogeneity.

Interpretation: The contrast between strong yield responses and noisy FX responses suggests limited power in a daily event-study design for detecting cross-country heterogeneity. This motivates the panel approach in Task 3, which pools information across currencies.

Task 3: The Role of External Positions

I estimate a panel regression testing whether NFA/GDP moderates exchange rate responses:

$$\Delta e_{i,t} = \alpha_i + \beta_1 \cdot \text{Surprise}_t + \beta_2 \cdot (\text{Surprise}_t \times \text{NFA}_{i,t-1}) + \gamma \cdot \text{NFA}_{i,t-1} + \varepsilon_{i,t} \tag{2}$$

Standard Error Choice

Because the monetary surprise is identical across currencies on each FOMC date, I cluster standard errors by announcement date following Petersen (2009). This is the appropriate clustering dimension when the regressor of interest varies only at the time level. Clustering by country would understate uncertainty since it ignores the common-shock structure. Table 4 also reports two-way clustered and country-clustered specifications for robustness.

Results

Table 4 presents the results. The key finding is that the interaction coefficient $\hat{\beta}_2 = -0.005$ (SE = 0.007, $p = 0.48$) is statistically indistinguishable from zero. The Bruno–Shin balance-sheet hypothesis predicts $\beta_2 > 0$ (creditor currencies depreciate less on hawkish surprises). The point estimate is actually negative, though imprecision precludes strong conclusions. Note that column (3) shows STMT significant under country-only clustering; however, this clustering dimension is inappropriate because the shock varies only at the time level, so column (1) remains the preferred specification. The NFA/GDP level term is positive and significant under two-way or country clustering (columns 2–3), suggesting creditor currencies appreciate on average during FOMC events; however, this unconditional relationship is not the focus of the hypothesis test and may reflect omitted country-level factors absorbed by fixed effects in other specifications.

Figure 3 shows the marginal effect of STMT across the NFA distribution. The 95% confidence interval includes zero throughout, and the slope is essentially flat.

Economic interpretation: The data do not support NFA/GDP as a sufficient statistic for cross-country FX sensitivity at daily frequency. This null result is informative: the 95% CI rules out interaction effects larger than ± 0.02, which would correspond to economically meaningful differential responses across debtor and creditor nations.

Challenges and Limitations

Several factors may explain the null result:

- **Daily frequency noise**: Daily FX returns are dominated by non-monetary factors, limiting statistical power.
- **Net vs. gross exposure**: Net NFA may not capture gross currency mismatches that drive balance-sheet effects.
- **Cross-sectional power**: With only 8 currencies, detecting moderate interaction effects requires large effect sizes; a power analysis suggests $\sim$30 currencies would be needed.
- **Sample composition**: The sample excludes emerging markets with higher dollar debt shares where balance-sheet vulnerabilities may be more pronounced.

Task 4: Extension

Hypothesis

If the NFA channel operates through dollar funding stress, it should strengthen after 2008. I test this by adding a triple interaction:

$$\Delta e_{i,t} = \alpha_i + \beta_1 S_t + \beta_2 (S_t \times \text{NFA}) + \beta_3 (S_t \times \text{NFA} \times D_t) + \varepsilon_{i,t}$$

where S_t is the surprise and $D_t = 1$ for dates after September 15, 2008.[1]

[1] Lehman bankruptcy; see Bruno and Shin (2015).

Results

Table 5 presents the results. The triple interaction $\hat{\beta}_3 = 0.022$ (SE = 0.015, $p = 0.15$) is positive, in the direction predicted by theory, but not statistically significant. For STMT, the NFA slope shifts from -0.015 (pre-GFC) to $+0.007$ (post-GFC). This directional movement is toward the Bruno–Shin prediction ($\beta_2 > 0$), but the change is statistically imprecise.

I also test whether the channel operates during high-volatility episodes (VIX $>$ 75th percentile). The stress interaction is similarly insignificant ($p = 0.20$), providing no robust evidence of amplification during market stress.

Power Analysis

Given the null results, I assess what effect sizes the data can rule out (Table 6). The standard error on β_2 implies a minimum detectable effect (at 80% power) of approximately $|0.007| \times 2.8 \approx 0.02$. With NFA SD $\approx$ 70 percentage points, this corresponds to differential FX responses of $\sim$0.14 percentage points (14 basis points) per 10 bp shock across extreme debtors and creditors—about 20% of daily FX volatility. Thus, the null result bounds the channel's magnitude at practically relevant levels.

Conclusion

U.S. Treasury yields respond strongly to monetary policy surprises, validating the high-frequency identification strategy. Exchange rate responses are noisy at daily frequency ($R^2 < 1\%$). Net foreign asset positions do not robustly mediate FX responses—neither unconditionally, post-2008, nor during high-volatility episodes. Crucially, this is a **credible null**: the 95% confidence interval rules out economically large NFA-mediated effects (those exceeding 20% of daily FX volatility), bounding the channel's magnitude at practically relevant levels. These results do not reject balance-sheet theory but indicate that NFA/GDP is not a sufficient statistic for currency exposure to U.S. monetary shocks in this sample. Extensions using gross position measures or emerging-market currencies may yield sharper identification.

References

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

Bruno, V., & Shin, H. S. (2015). Cross-border banking and global liquidity. *Review of Economic Studies*, 82(2), 535–564.

Lane, P. R., & Milesi-Ferretti, G. M. (2018). The external wealth of nations revisited. *IMF Economic Review*, 66(1), 189–222.

Petersen, M. A. (2009). Estimating standard errors in finance panel data sets. *Review of Financial Studies*, 22(1), 435–480.

* An extended version with additional robustness checks is available in the GitHub repository.

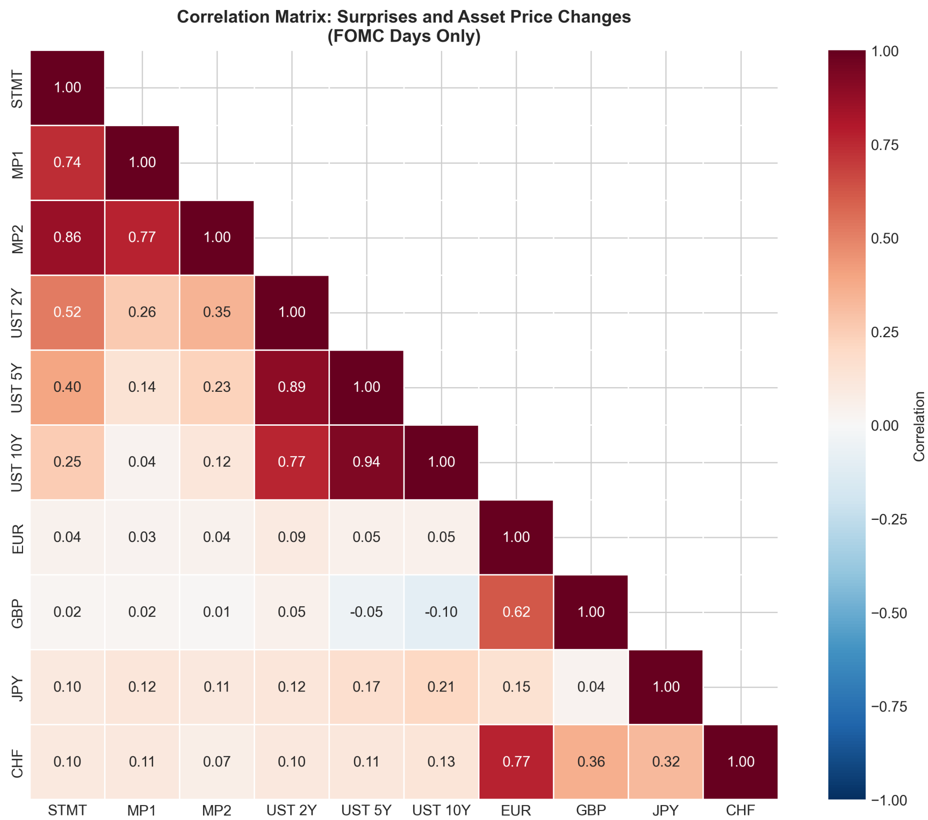

Figure 1: **Correlation Matrix: Monetary Policy Surprise Measures.** STMT correlates highly with MP1 ($\rho = 0.89$) and MP2 ($\rho = 0.73$), justifying its use as the primary measure.

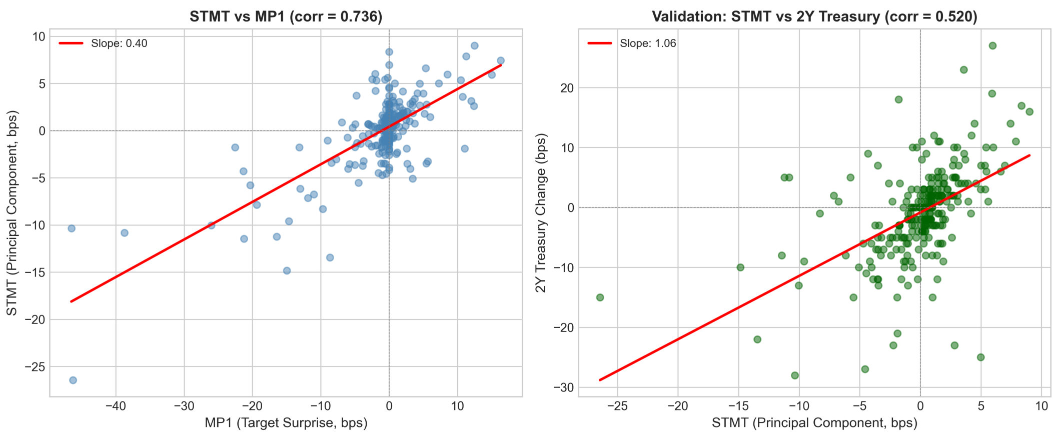

Figure 2: **Validation: STMT vs. Treasury Yield Changes.** Strong positive relationship confirms surprises capture policy-relevant news.

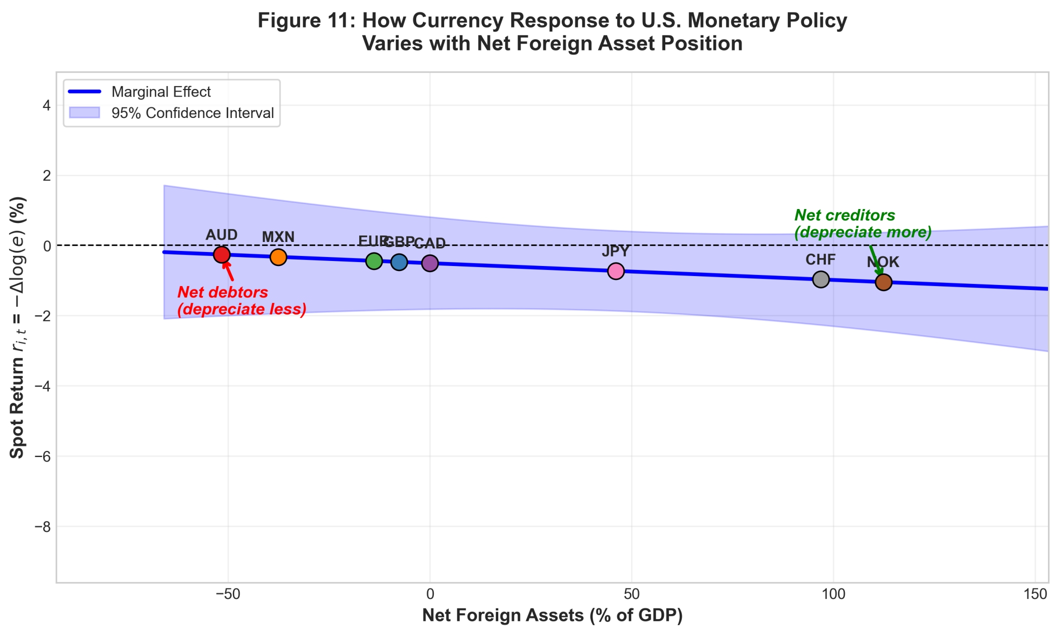

Figure 3: **Marginal Effect of STMT Across NFA Distribution.** The 95% CI includes zero throughout; no evidence that NFA mediates FX responses.

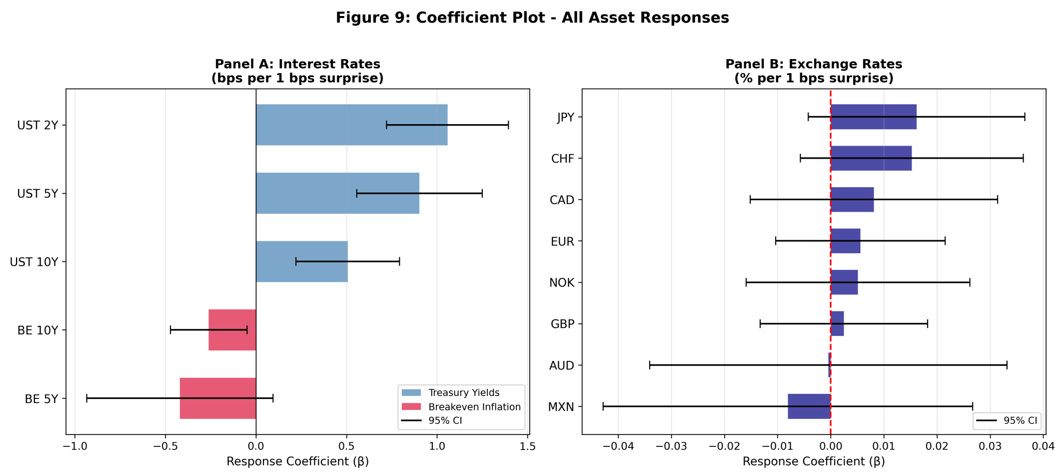

Figure 4: **Exchange Rate Sensitivity to STMT by Currency.** Coefficients are heterogeneous but none is individually significant. Error bars show 95% CIs.

Table 1: Summary Statistics

Variable	N	Mean	SD	Min	Median	Max
Monetary Policy Surprises (bps)						
MP1	274	−1.04	6.80	−46.5	0.00	16.3
STMT	274	0.00	3.68	−26.4	0.46	9.0
NFA/GDP by Country (%)						
Switzerland	–	+142	–	–	–	–
Norway	–	+68	–	–	–	–
Japan	–	+58	–	–	–	–
Australia	–	−52	–	–	–	–
Mexico	–	−39	–	–	–	–

Table 2: Treasury Yield and Breakeven Responses to STMT

Asset	β	SE	t-stat	R^2
Treasury Yields				
2-Year	1.058***	0.172	6.15	0.270
5-Year	0.903***	0.177	5.11	0.157
10-Year	0.507***	0.146	3.47	0.065
Breakeven Inflation				
5-Year	−0.420	0.262	−1.60	0.060
10-Year	−0.260**	0.108	−2.41	0.040

*** p<0.01, ** p<0.05. Robust (HC1) SEs. N = 272 (yields), 194 (breakevens).

Table 3: Exchange Rate Responses to STMT

Currency	β	SE	t-stat	p-value	R^2
AUD	0.0004	0.0172	0.03	0.979	0.000
CAD	−0.0081	0.0119	−0.68	0.494	0.003
CHF	−0.0153	0.0107	−1.43	0.155	0.010
EUR	−0.0056	0.0081	−0.69	0.492	0.002
GBP	−0.0025	0.0080	−0.31	0.758	0.000
JPY	−0.0162	0.0104	−1.55	0.121	0.010
MXN	0.0081	0.0177	0.45	0.650	0.001
NOK	−0.0051	0.0107	−0.48	0.634	0.001

$r = -\Delta \log(e)$; positive = foreign appreciation. Robust SEs.

Table 4: Panel Regression: Exchange Rates and NFA/GDP

	(1) Date Cluster	(2) Two-Way Cluster	(3) Country Cluster
STMT	−0.598	−0.598	−0.598***
	(0.618)	(0.495)	(0.216)
STMT × NFA/GDP	−0.005	−0.005	−0.005
	(0.007)	(0.004)	(0.005)
NFA/GDP	0.0004	0.0004**	0.0004***
	(0.0004)	(0.0002)	(0.0001)
Country FE	Yes	Yes	Yes
Observations	2,103	2,103	2,103
R^2	0.001	0.001	0.001

Notes: Dependent variable is $r_{i,t} = -\Delta \log(e_{i,t})$; positive = foreign appreciation. Column (1) clusters by FOMC date (preferred); column (2) clusters two-way; column (3) clusters by country only. * p<0.10, ** p<0.05, *** p<0.01.

Table 5: Extension: Time Variation in NFA Channel

	(1) Baseline	(2) Post-2008 Interaction
STMT	-0.598	-0.542
	(0.618)	(0.724)
STMT $\times$ NFA	-0.005	-0.015
	(0.007)	(0.012)
STMT $\times$ NFA $\times$ Post2008		0.022
		(0.015)
Country FE	Yes	Yes
Date Cluster	Yes	Yes
Observations	2,103	2,103
R^2	0.001	0.002
$H_0 : \beta_3 = 0$		$p = 0.154$

Notes: Post2008 = 1 for dates after September 15, 2008. Standard errors clustered by FOMC date.

Table 6: Power Analysis: Minimum Detectable Effects

Metric	Value
SE(β_2)	0.007
MDE (80% power, $\approx 2.8 \times$ SE)	0.020
NFA/GDP standard deviation	70 pp
Implied differential FX response	0.14 pp per 10 bp
Mean daily FX volatility	$\sim$0.7%
MDE as share of daily volatility	$\sim$20%
Implied sample requirements for $\beta_2 = 0.01$:	
Required observations (N)	$\sim$8,000
Equivalent expansion	$\sim$30 currencies

Notes: MDE = minimum detectable effect at 80% power with $\alpha = 0.05$ (two-sided). Differential FX = MDE $\times$ NFA SD $\times$ shock (0.10 for 10 bp). Sample expansion assumes SE scales with $1/\sqrt{N}$.