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August 20, 2023

Abstract

Bauer et al. (2022) derive market-based monetary policy uncertainty and uncover an 'FOMC uncertainty cycle' characterized by a fall of uncertainty after FOMC announcements and its subsequent built-up. Then, the authors show that the financial markets' response to monetary policy announcements depends on the level of short-rate uncertainty on the day before the FOMC announcement. First, we reproduced the paper's findings, though with `Matlab` version-specific issues. Second, we tested the robustness of the two main results of the paper. We show that the uncertainty cycle in the monetary policy uncertainty is confirmed when the crisis period is included in the sample or when the median instead of the average of changes in the monetary policy uncertainty is considered. However, the FOMC uncertainty cycle does not appear when the monetary policy uncertainty index (Husted et al. 2020) or the daily economic policy uncertainty index (Baker et al. 2016) are used as uncertainty proxies.

KEYWORDS: Uncertainty, Monetary policy, Replication.

JEL CODES: E43, E52.

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1 Introduction

Bauer et al. (2022), henceforth BLM, investigate the role of uncertainty in the transmission of monetary policy shocks to financial markets. They use the prices of Eurodollar futures and options representing market-based uncertainty to derive the measure of uncertainty surrounding the future short-term interest rates, the so-called *short-rate uncertainty*. Then, BLM focus on uncertainty developments around 197 scheduled FOMC announcements, denoted as *monetary policy uncertainty*, between January 1994 and September 2020, with the period of the Global Financial Crisis from July 2007 to June 2009 excluded, and uncover a systematic cyclical pattern with uncertainty falling after FOMC announcements and gradually increasing over the following two weeks. Finally, BLM tested the effect of monetary policy uncertainty on the transmission of monetary policy using the event study method. The main results show that monetary policy uncertainty has a significant effect on the transmission of monetary policy on financial markets that is distinct from the effect of monetary policy surprises, and the response of financial markets to monetary policy is *"generally more muted when the uncertainty is high"* (p. 1304).

In this paper, we investigate whether the BLM's results are reproducible and further test their replicability to four robustness checks. First, we include the years of the Global Financial Crisis within the sample. Next, we test whether the highest drops in monetary policy uncertainty do not drive the monetary policy cycle by using the median instead of the average change of uncertainty around the FOMC meetings. Third, we replace the BLM's preferred measure of monetary policy uncertainty with the popular Economic Policy Uncertainty Index (Baker et al. 2016; EPU), which is intended to follow broader uncertainty trends in the economy to check if the uncertainty cycle appears at other uncertainty indicators. Similarly, we compare the FOMC uncertainty cycle inferred by BLM with the behavior of the news-based monetary policy uncertainty index by (Husted et al. 2020; MPU). Fourth, we reestimate the impact of uncertainty on the transmission of monetary policy to financial markets with the EPU and compare the results with those

of BLM.

The BLM results were reproduced using the data and scripts for `Matlab` and `R` available from Zenodo repository and linked from journal webpage. The results were reproduced using `Matlab 2020b` after minor code adjustments. However, with `Matlab 2022`, the scripts result in dozens of errors. On the other hand, the outputs generated by `R` were reproduced successfully.

Our replications, including data from the Global Financial Crisis, did not affect the authors' main results. The existence of the FOMC uncertainty cycle was also corroborated when the median path of monetary policy uncertainty around FOMC meetings was considered rather than the average that can be affected by outliers. On the other hand, we could not confirm the existence of the uncertainty cycle with the EPU and MPU indices. Those two indices are, however, based on news searches in the leading newspapers, while the BLM's index is derived from the option prices similarly to the VIX index. Hence, both types of indices track different components of uncertainty. Along with this sensitivity check, we failed to confirm the effect of EPU on the transmission of monetary policy to financial markets that is present when the monetary policy uncertainty by BLM is used.

2 Reproducibility

The replication package contains a detailed `Readme.pdf` file linking all tables and figures with particular `R` or `Matlab` scripts, except for calculating the uncertainty series from the data on prices of Eurodollar futures and options because those data are proprietary. BLM mentions this reason in the online Appendix (p.1).

The `R` scripts reproduced the respective results directly. On the other hand, the `Matlab` scripts were more complicated to run. With `Matlab R2020b`, the `readtable` function returned errors; nevertheless, removing `.csv` from the filename solved the problem: `(readtable('data\tabf1_data.csv') -> readtable('data\tabf1_data'))`.

The authors recommend `Matlab R2021a` Update 3 as a minimum software requirement. However, already with `Matlab R2022a` it proved impossible to reproduce Figure 3,

Table 4, and figures and tables of the appendices C-D due to errors that could not be easily corrected. This is understandable because BLM did not have access to `Matlab R2022a` when they prepared their code.

Reproduced figures and tables and a list of errors appear in the Appendix.

3 Replication

One of the most interesting results of the BLM's paper is the existence and magnitude of the FOMC uncertainty cycle. Falls in uncertainty around FOMC meetings have been documented by Fernandez-Perez et al. (2017), Amengual and Xiu (2018), and others using VIX. However, the increases in VIX prior to the FOMC meeting and subsequent falls have been considered modest. BLM themselves compare the behavior of their monetary policy uncertainty and the VIX around the FOMC dates. Unlike monetary policy uncertainty, VIX increases two days before the FOMC meeting and decreases the day after, but the magnitude of this jump is just one-fourth of the fall in monetary policy uncertainty after the FOMC meeting (see BLM, Figure D.2, Online Appendix; the comparison is based on uncertainty series normalized by the full-sample standard deviation of daily changes).

Therefore, in our replication, we focus on the robustness of the uncertainty cycle in a battery of sensitivity checks. We then check the robustness of the impact of uncertainty on the transmission of monetary policy to financial markets.

3.1 Inclusion of the crisis period in the sample

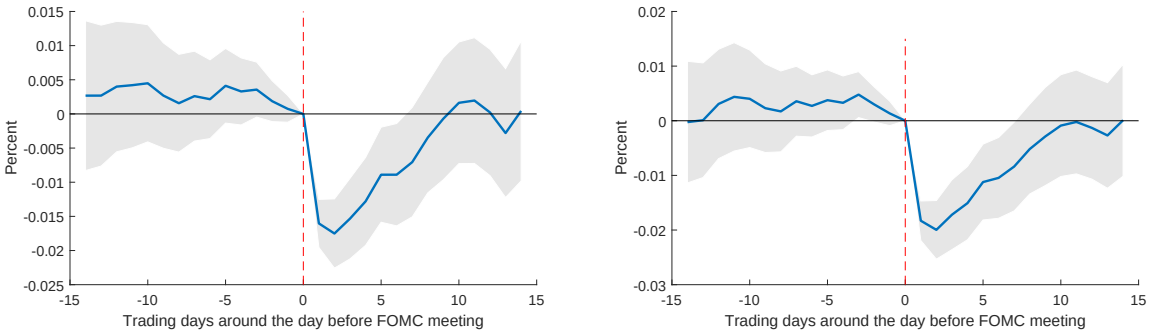
Most of the BLM's results are based on a sample of scheduled FOMC meetings between January 1994 and September 2020, except for the period from July 2007 to June 2009 covering the Global Financial Crisis. In footnote 16, the authors claim that their results "remain essentially unchanged" when they include the unscheduled announcements in the sample.

Regarding the 2007-2009 period, BLM argue that the spread between LIBOR and the Fed's policy rate is mostly stable; therefore, it is possible to use LIBOR derivatives to infer the uncertainty about the policy rate. However, during the Global Financial Crisis, when

the spread rapidly increased (see the reproduced Figure A.1), the conditional volatility of LIBOR futures became affected by the expectations about the future spread between the LIBOR and the Fed's policy rate, along with the uncertainty about the future policy rate itself. Thus, as a *"pragmatic solution"* (BLM, 2021, p. 1294), they decided to exclude the crisis years from the sample.

However, during the crisis, the Fed usually aims to stabilize financial markets and the economy as a whole and, since the Great Recession, to decrease uncertainty by providing guidance about the intended monetary policy over the upcoming period. Therefore, we replicated Figure 3 of BLM's paper with the years of the Global Financial Crisis included. The results presented in Figure 1 show that the FOMC uncertainty cycle is robust to the inclusion of the 2007-2009 period, and the fall in uncertainty is even higher than in the baseline specification of BLM.

Figure 1: The FOMC uncertainty cycle



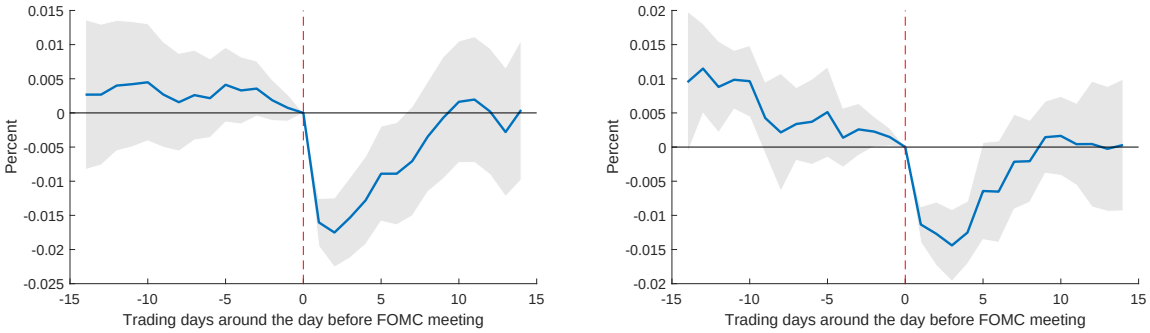
Notes: Changes in uncertainty over the FOMC meeting cycle, measured as the average change in short-rate uncertainty on trading days around scheduled FOMC announcements, relative to the day before the announcement (dashed red line), i.e., mean of $SRU_{t+j-1} - SRU_{t-1}$). Left: Scheduled FOMC meetings, Jan. 1994 - Sep. 2020, excluding July 2007 - June 2009. Right: Scheduled FOMC meetings, full sample.

3.2 Median changes of the monetary policy uncertainty

Next, we replaced the average path of the short-rate uncertainty around FOMC announcements with the median to check whether the drop of the uncertainty is not driven by several high drops, possibly after the most important FOMC meetings and possibly during periods of financial instability. These results are presented in Figure 2 and show that with the median, the uncertainty cycle remains present in the data but with a less pronounced uncertainty decrease at the FOMC announcement. On the other hand, the

short-rate uncertainty is gradually declining before the announcement date.

Figure 2: The FOMC uncertainty cycle: average and median

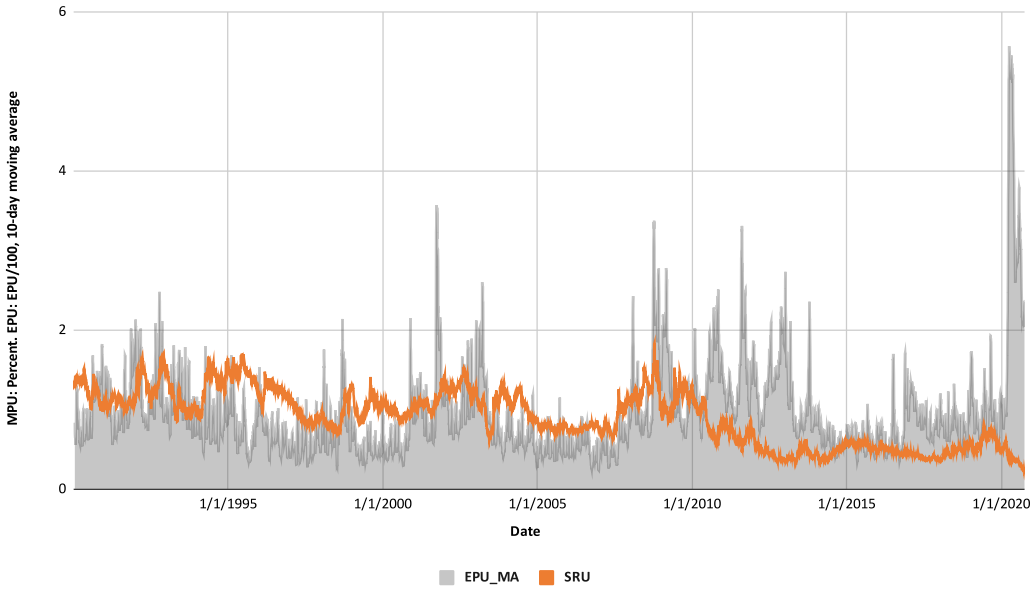


Notes: Changes in uncertainty over the FOMC meeting cycle, measured as average (left panel) and median (right panel) change in short-rate uncertainty on trading days around scheduled FOMC announcements, relative to the day before the announcement (dashed red line).

3.3 Daily Economic Policy Uncertainty around FOMC dates

Third, we check whether the FOMC announcement cycle can be observed with alternative uncertainty indicators. Although numerous uncertainty indicators have been developed (see Cascaldi-Garcia et al. 2023, for the most recent survey), only a few are available on a daily frequency. BLM compare their index to other uncertainty indices derived from eurodollar futures (Bundick et al. 2017; Swanson and Williams 2014). However, daily uncertainty data are also available for the news-based Economic Policy Uncertainty (daily EPU; Baker et al. 2016), so it is possible to compare the monetary policy uncertainty by BLM with another popular indicator of uncertainty that has been widely used since its publication (as of August 31, 2023, Baker et al. 2016 collected nearly ten thousand Google Scholar citations). The evolution of both indices is depicted in Figure 3. Several differences stand out. First, the EPU is more noisy than the short-rate uncertainty. Second, the behavior of both series differs during some of the past periods. During the Great Recession, the short-rate uncertainty declined faster than the EPU measuring broader economic uncertainty because of the zero-lower bound and forward guidance. Then, during the COVID, the daily EPU peaks to all-time-high values while the short-rate uncertainty falls to its all-time lows. These differences reflect different driving forces behind the evolutions of both indices.

Figure 3: Monetary policy uncertainty and economic policy uncertainty



Notes: Daily EPU is divided by 100 to make the scale comparable to the short-rate uncertainty. For better graph readability, the EPU was smoothed by a 10-trading days moving average. Source: US EPU Index.

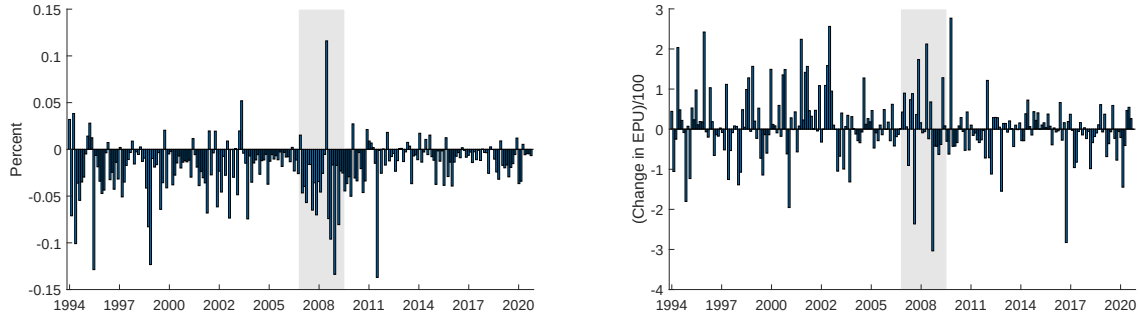
When changes in FOMC dates are considered, the monetary policy uncertainty is skewed towards negative values, in line with the idea that FOMC announcements decrease the monetary policy rate uncertainty (Figure 4 left panel). On the other hand, the average of the changes in EPU is distributed around zero more evenly, tilted to positive values (Figure 4 right panel). Table 1, with descriptive statistics, confirms that while the mean of the changes in the EPU is positive, the mean is negative for changes in the monetary policy uncertainty.

Table 1: Descriptive statistics

	FOMC		Non-FOMC	
	MPU	EPU	MPU	EPU
Observations	197	197	6032	8832
Mean	-0.016	0.056	0.000	-0.001
t-statistic	-8.935	1.084	1.374	-0.131
SD	0.025	0.726	0.019	0.626
Skewness	-1.644	0.529	1.305	-0.008
Cumulative change	-3.158	11.024	2.078	-7.713
MPU & EPU correlation	0.0057		0.0237	

Notes: EPU and Monetary Policy Uncertainty at the FOMC announcements (Replication of Table 2. Jan. 1994 to Sept. 2020).

Figure 4: EPU and Monetary Policy Uncertainty at the FOMC announcements



Consequently, the path of the uncertainty profile around FOMC announcements is different, and the FOMC uncertainty cycle with uncertainty resolved by the announcements and then gradually ramping up over the next two weeks does not appear in the EPU (Figure 5, right panel). Instead, the EPU increases shortly before the FOMC meeting and decreases afterward. These uncertainty developments mean that the relative frequency of uncertainty articles in the leading newspapers increases temporarily around the FOMC meetings, while the financial markets follow the information about future interest rates constantly.

Interestingly, the evolution of the EPU around FOMC announcements resembles the monetary policy uncertainty index developed by Husted et al. (2020), which is based on the news in newspapers, like the EPU index.[1]

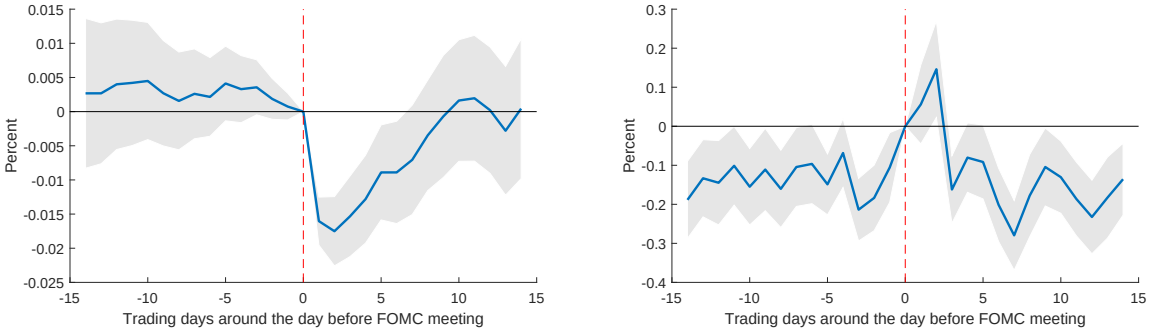
Therefore, two conclusions can be drawn. First, the BLM's short-rate uncertainty and the EPU track different types of uncertainty. In other words, financial markets price uncertainty differently and at different times than how uncertainty is reflected in the news. Second, the FOMC uncertainty cycle is indicator- and market-specific because this cycle is not visible on other indicators.

3.4 Impact of uncertainty on the transmission of monetary policy to financial markets.

Our last sensitivity check addresses the impact of monetary policy uncertainty on the transmission of monetary policy to financial markets. BLM use a methodology of event

[1] Although Husted et al. (2020) did not make their index at daily frequency publicly available; they present the behavior of their Monetary Policy Uncertainty around FOMC announcements in Figure A.1 of their paper.

Figure 5: Monetary Policy Uncertainty and EPU around the FOMC announcements



Notes: Daily EPU is divided by 100 to make the scale comparable to the short-rate uncertainty. Source: US EPU Index.

study regressions. They estimate the response of various asset prices to monetary policy surprises, monetary policy uncertainty (= change in the short-rate uncertainty on a day of FOMC announcements with respect to the day before the FOMC announcement), and an interaction effect between the monetary policy surprises and lagged level of short-rate uncertainty. The interaction effect measures how the transmission of monetary policy surprises is affected by the ex ante level of short-rate uncertainty.

In their benchmark specification with the 5-year nominal yield, the respective coefficient at the interaction term is -0.66, implying that uncertainty weakens the transmission of monetary policy to the 5-year bond yield. Similar weaker transmission is reported for 10-year bond yields, 10-year TIPS yields, S&P 500, the VIX, and the returns on a foreign currency portfolio short G9 currencies and long the dollar. When the period 2007-2009 is included in the estimation sample, the coefficient decreases (in absolute value) to -0.553. With the EPU, the interaction coefficient remains negative, but it is not statistically significant. The t-value is -1.610 (-0.123 with the 2007-2009 period included), less than one-half of the t-value of a regression with the monetary policy uncertainty. The interaction term remains statistically significant at conventional levels only when considering the 10-year TIPS yields and the VIX.

Nevertheless, the BLM's finding that the level of uncertainty affects the magnitude of financial market reactions to monetary policy surprises depends on the choice of the indicator of uncertainty as well.

Table 2: Transmission of monetary policy to financial markets (Replication of Table 4)

Dependent variable: Five-year nominal yield						
Panel A:	MPU original			MPU (2007-2009 included)		
MPS	0.65	0.53	1.26	0.74	0.61	1.23
	[8.64]	[6.33]	[6.51]	[7.20]	[5.82]	[3.71]
MPU		0.60	0.81		0.72	0.92
		[2.76]	[3.49]		[2.91]	[3.83]
$MPS \times MPU_{-1}$			-0.66			-0.55
			[-3.54]			[-1.96]
R^2	0.46	0.51	0.57	0.39	0.45	0.49
Panel B:	Replicated with EPU			EPU (2007-2009 included)		
MPS	0.65	0.66	0.84	0.74	0.74	0.75
	[8.64]	[9.16]	[8.00]	[7.20]	[7.23]	[5.21]
EPU		0.01	0.00		-0.00	-0.00
		[1.31]	[0.82]		[-0.12]	[-0.10]
$MPS \times EPU_{-1}$			-0.15			-0.01
			[-1.61]			[-0.12]
R^2	0.46	0.47	0.49	0.39	0.39	0.40

Notes: This table shows the replication of Table 4 from BLM. The dependent variable is the 5Y nominal yield. Panel A reports the regression results, as BLM, when MPU series are used. In addition, the right-hand side reports regression results when data from 2007-2009 are included. Panel B reports the same regression results when EPU substitutes for MPU. Brackets: t-values.

4 Conclusion

In our replication study, we have successfully reproduced the existence of the FOMC uncertainty cycle of Bauer et al. (2022) and the estimates of the impact of the monetary policy uncertainty on the transmission of monetary policy, although with the need to use a specific Matlab version to avoid error messages.

Based on our results, the estimated FOMC uncertainty cycle, the most interesting result of the paper, was reasonably robust to changes in the sample and to the exclusion of outliers. However, the other uncertainty indicators that we have considered, the Economic Policy Uncertainty Index or the Monetary Policy Uncertainty Index, both based on scrapping relevant keywords from the leading newspapers, exhibit different behavior around the FOMC meetings with a temporary increase of uncertainty and without any apparent cycle lasting longer than a few days. Therefore, the results of Bauer et al. (2022) cannot be generalized to other types of uncertainty measures that track different uncertainty components.

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Appendix A

A1 Replicated figures

Figure A1: Replicated Figure 1

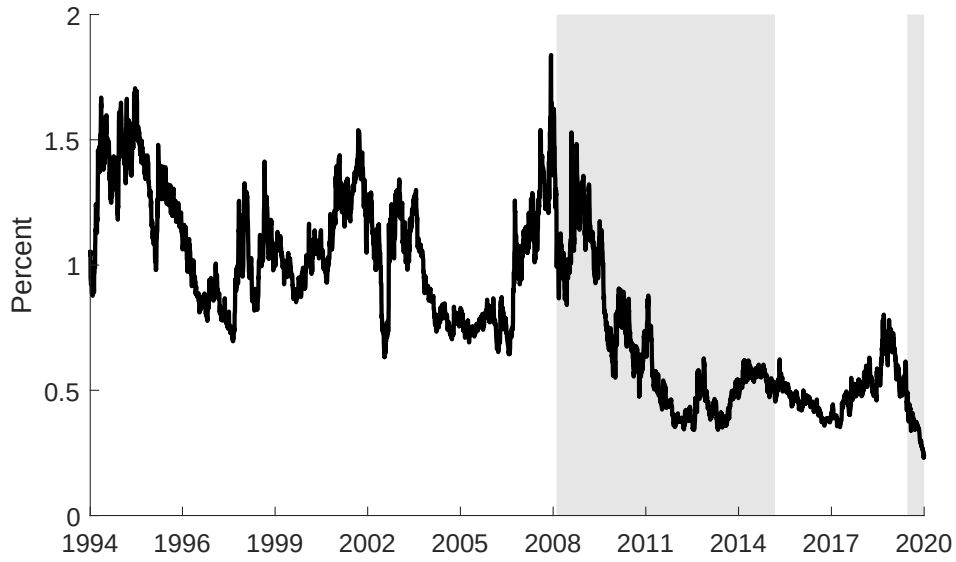


Figure A2: Replicated Figure 3

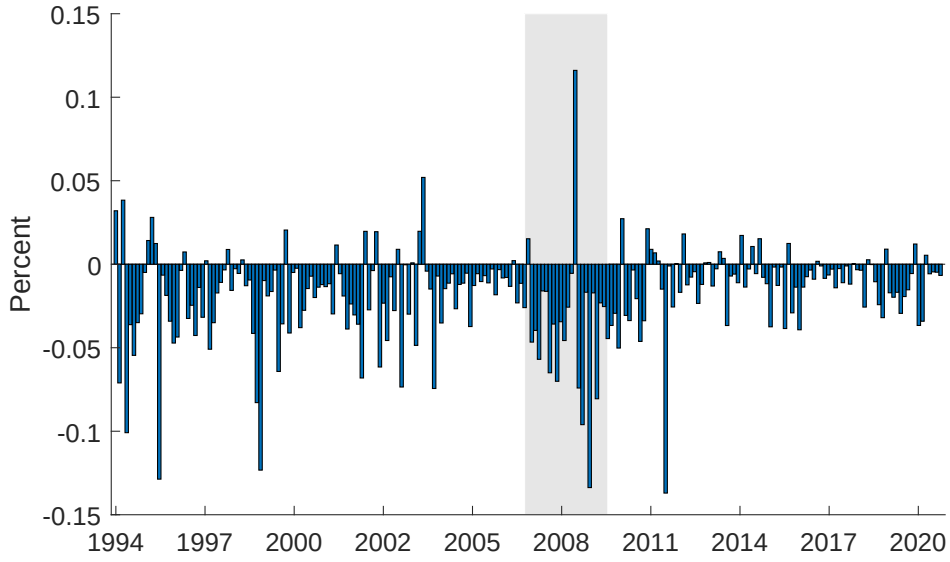
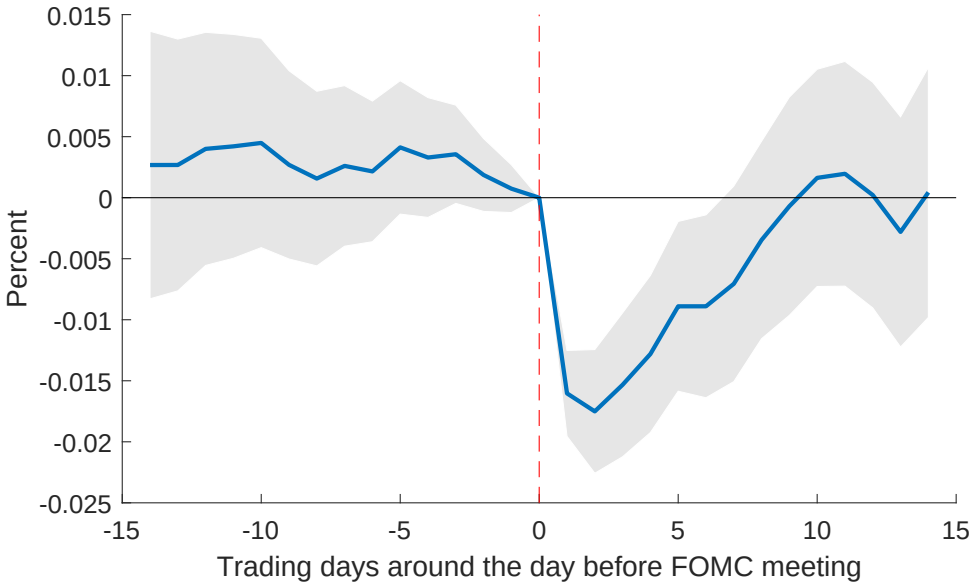


Figure A3: Replicated Figure 3



A2 Replicated tables

Table A1: Replication of Table 2

	Jan. 1994 to Sept. 2020		Jan. 2012 to Dec. 2018		
	FOMC	Non-FOMC	All FOMC	With SEP	W/o SEP
Observations	197	6032	56	29	27
Mean	-0.016	0.000	-0.008	-0.013	-0.002
t-statistic	-8.935	1.374	-4.604	-5.121	-1.355
SD	0.025	0.019	0.013	0.014	0.009
Skewness	-1.644	1.305	-0.555	-0.329	0.680
Cumulative change	-3.158	2.079	-0.439	-0.378	-0.060

Table A2: Replication of Table 4

	Five-year nominal yield			Ten-year nominal yield			Ten-year TIPS yield		
MPS	0.646	0.527	1.261	0.456	0.321	0.739	0.445	0.329	1.255
	[8.642]	[6.332]	[6.510]	[7.421]	[4.784]	[4.416]	[6.056]	[4.345]	[3.567]
MPU		0.601	0.805		0.685	0.856		0.723	0.877
		[2.759]	[3.487]		[2.824]	[3.328]		[3.126]	[3.624]
$MPS \times MPU_{-1}$			-0.665			-0.379			-0.975
			[-3.543]			[-2.335]			[-2.681]
R^2	0.464	0.506	0.569	0.274	0.338	0.376	0.198	0.261	0.355
	S &P 500			VIX			Dollar index		
MPS	-3.310	-1.604	-11.222	4.068	-0.279	16.952	2.507	1.787	12.297
	[-3.321]	[-1.263]	[-3.132]	[2.831]	[-0.120]	[2.992]	[3.827]	[2.561]	[4.387]
MPU		-8.658	-10.877		22.059	26.603		3.658	6.010
		[-1.749]	[-2.160]		[1.729]	[1.949]		[1.936]	[4.007]
$MPS \times MPU_{-1}$			8.726			-15.627			-9.533
			[2.821]			[-2.754]			[-4.418]
R^2	0.053	0.090	0.132	0.036	0.144	0.209	0.111	0.136	0.317

Appendix B

In `matlab` R2022b `fig3.m`, `tab4.m`, `fig_D1-2`, `tabD1-3`, `tabE1-3` could not be replicated.

Detailed errors:

`fig3.m`:

```
Error using fig3
The value of 'Data' is invalid. Expected input to be one of these types:
double, table, timetable
Instead its type was logical.
```

`fig_D1.m`:

```
Error using hac
Too many output arguments.
Error in olsrob (line 5)
[EstCov,robse,~] = hac(X,varargin{:},
'type','HC','weights','HC0','display','off'); % robse: robust std err,
Error in fig_D1 (line 90)
[mdl,robse,EstCov,pValue,tStat] = olsrob(table(monshk_daily(logical(fomcdataeff.dum_baseline))
,mpu(logical(fomcdataeff.dum_baseline))));
```

`fig_D2.m` :

```
Error using fig_D2
The value of 'Data' is invalid. Expected input to be one of these types:
double, table, timetable
Instead its type was logical.
```

`tab4.m`:

```
Error using hac
Too many output arguments.
Error in olsrob_nodisp (line 5)
[EstCov,robse,~] =hac(X,varargin{:},'type','HC','weights','HC0','display','off'); % robse: robust std err,
Error in tab4 (line 31)
 [reg1 ,~,~,~,opt1.tstat ] = olsrob_nodisp(table(mps,asset));
```

tabD1.m:

```
Error using hac
Too many output arguments.
Error in olsrob_nodisp (line 5)
[EstCov,robse,~] =hac(X,varargin{:},'type','HC','weights','HC0','display','off'); % robse: robust std err,
Error in tabD1 (line 160)
[reg,~,~,pval,tstat] = olsrob_nodisp(table(drift,mpu));
```

tabD2.m:

```
Error using hac
Too many output arguments.
Error in olsrob_nodisp (line 5)
[EstCov,robse,~] =hac(X,varargin{:},'type','HC','weights','HC0','display','off'); % robse: robust std err,
Error in tabD2 (line 20)
[reg1,~,~,~,opt1.tstat] = olsrob_nodisp(table(mps,mpu));
```

tabD3.m:

```
Error using hac
Too many output arguments.
Error in olsrob_nodisp (line 5)
[EstCov,robse,~] =hac(X,varargin{:},'type','HC','weights','HC0','display','off'); % robse: robust std err,
Error in tabD3 (line 11)
[reg1,~,~,~,opt1.tstat] = olsrob_nodisp(table(news.sched_ind, news.empall_ind,
news.cpiall_ind, news.ppiall_ind,news.retall_ind,news.gdpall_ind,news.ismall_ind, news.mpu));
```

tabE1.m:

```
Error using hac
Too many output arguments.
Error in olsrob_nodisp (line 5)
[EstCov,robse,~] =hac(X,varargin{:},'type','HC','weights','HC0','display','off'); % robse: robust std err,
Error in tabE1 (line 64)
[reg1 ,~,~,~,opt1.tstat ] = olsrob_nodisp(table(mps,asset));
```

tabE2.m:

```
Error using hac
Too many output arguments.
Error in olsrob_nodisp (line 5)
[EstCov,robse,~] =hac(X,varargin{:},'type','HC','weights','HC0','display','off'); % robse: robust std err,
Error in tabE2 (line 33)
[reg3 ,~,~,~,opt3.tstat ] = olsrob_nodisp(table(tf,pf,mpu,intertf,interpf,mpu_level_lag,asset));
```

tabE3.m:

```
Error using hac
Too many output arguments.
Error in olsrob_nodisp (line 5)
[EstCov,robse,~] =hac(X,varargin{:},'type','HC','weights','HC0','display','off'); % robse: robust std err,
Error in tabE3 (line 34)
[reg1 ,~,~,~,opt1.tstat ] = olsrob_nodisp(table(mps,asset));
```