International Monetary Policy Spillovers: A GDP-Mimicking Approach

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Motivation

- (Rey 2015) suggests there is a global financial cycle in asset prices driven by US monetary policy as the center country.
- This is suggestive that both *financial* and *real* spillovers from monetary policy of the "center" country abroad are large.
- In this project, we investigate the international transmission of monetary policy from a non-traditional empirical perspective.
- Using high frequency data on monetary announcements, **how do monetary shocks affect financial markets, both domestically and abroad?**

Empirics: GDP-mimicking approach

- To identify real spillovers of monetary shocks to countries abroad, we use high-frequency **economic "mimicking" or tracking portfolios (ETPs)**, constructed using intraday asset returns.
- ETPs are linear combinations of asset returns that best mimic "news" about real output, inflation, or unemployment i.e. connect asset prices to news about real variables.

Literature review

- Literature on policy shocks and asset prices: Kuttner (2001), and Bernanke and Kuttner (2005) introduce methodology for estimating policy shocks using interest rate futures.
- ETPs: Breeden, Gibbons, and Litzenberger (1989) construct "economic tracking portfolios" or "maximum correlation portfolios" for *current* consumption, to test the CCAPM. Lamont (2001) and Vassalou (2003) constructs ETPs for *future* economic variables, using unexpected returns.
- MP shocks: Gurkaynak, Sack and Swanson (2005), and Swanson (2016) look at impact of monetary policy on asset prices using a factor structure. They decompose asset price responses around FOMC announcements into "*target*," "*path*," and "*lsap*" factors, with the latter two a proxy for "forward guidance" and "QE," respectively, during the ZLB period.

Literature review

- MP shocks: Gurkaynak (2005) pursues an idea different from that of GSS (2005). He decomposes market-based policy shocks into **timing**, **level**, and **slope** components.
    - **timing**: transitory surprise that by definition leaves expected interest rates after the next FOMC announcement unchanged.
    - **level**: orthogonal to the **timing** surprises and measures a parallel shift of interest rate expectations.
    - **slope**: orthogonal to **level** and **timing** and captures revisions to expected pace of interest rate changes.
- GSS (2005) don't separate their *target* surprise into **timing** and **level**
    - *target* ≈ **timing** + **level**
    - *path* ≈ **slope**"

Measuring monetary policy shocks

- Monetary policy shock defined as **surprise** component of monetary policy that is unanticipated by market participants.
- There are 3 different approaches in the literature to measure monetary shocks: **(1)** structural/Cholesky VAR approach, **(2)** residuals from Taylor rule projections, or **(3)** market-based measures i.e. changes in spot or futures rates on central bank announcement days.
- The identifying assumption for the market-based shock to be a good instrument for monetary policy is that during the announcement the market rate only responds to news about monetary policy, and not other news related to the economy during that period.

Measuring US monetary policy shocks

- Interest rate futures for the Fed Funds rate are contracts between the buyer and seller agreeing to lock in today the price of the 30-day average Fed Funds rate at the contract's expiration.
- For example, suppose the *front-month* contract is traded at 95 cents to the dollar at the beginning of a month where an FOMC meeting will occur. This gives an implied rate of 5%, which is what investors believe will be the *average* Fed Funds rate for the *current* month.
- If the current Fed Funds rate is less than 5%, investors implicitly believe the Fed will tighten rates at this month's FOMC meeting.
- The futures rate therefore provides a good signal of what investors anticipate the future path of interest rates to be, and their prediction of the outcome of the FOMC meeting.

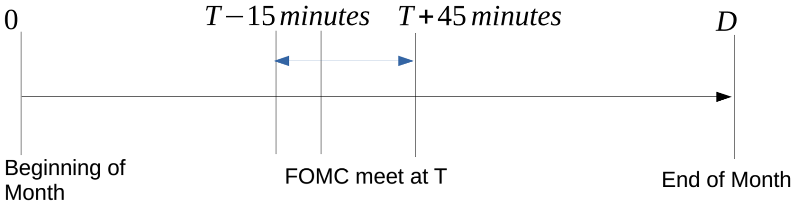
Computing Fed Funds rate shocks

- Futures rate changes during a short window around an FOMC announcement provide a measure of the **unanticipated** component of the change in the Fed Funds rate
- The identifying assumption is that during the time of the announcement, the Fed Funds futures rate is responding **only** to the FOMC press release.
- For an event taking place on day d_0, the day of the closest FOMC announcement, with D_0 days in that month, the surprise target funds rate change is calculated from the change in the rate implied by the *front-month* futures contract.

Computing Fed Funds rate shocks

- Following Gurkaynak, Sack and Swanson (2005), we construct a "wide" window around each FOMC announcement at time *t* to compute the futures rate change 15 minutes *prior* to and 45 minutes *after* the announcement

$$\Delta f1_t = f1_{t+45} - f1_{t-15}$$



Computing Fed Funds rate shocks

- When looking at the *front-month* contract, the settlement price is based on what investors think the monthly *average* Fed Funds rate is for the *current* month. Changes in implied 30-day futures rate $\triangle f1_t$ must be scaled up by a factor related to the number of days in the month affected by the change, equal to $D_0 - d_0$ days.

$$MP1_t = \frac{D_0}{D_0 - d_0} \Delta f1_t^{surprise}$$

- $MP1_t$ is our *current* FOMC policy surprise i.e. "Kuttner" (2001) surprise.

Timing, Level, and Slope for the US

$$MP1_t = \alpha_1 + \beta_1 level_{US,t} + timing_{US,t}$$

$$\Delta US3MT_t = level_{US,t}$$

$$\Delta US2YT_t = \alpha_2 + \beta_2 level_{US,t} + \gamma_2 timing_{US,t} + slope_{US,t}$$

- $\Delta US3MT_t$ and $\Delta US2YT_t$ are changes in 3-month and 2-year US Treasuries 15 minutes *prior* to and 45 minutes *after* the announcement

Monetary policy shocks for foreign countries

- $MP1_t$-analog for foreign countries difficult to construct. There do not exist *liquid* futures contracts analogous to the 30-day Fed Funds futures.
- Following Brusa et al. (2016) and Miranda-Agrippino (2016), we construct *current* policy surprises as yield changes in a foreign central bank's 90-day/3-month interbank rate.
- Currently constructing panel of shocks for 9 foreign regions/countries, each with a central bank. **Today, we focus on AU and CAN**.

Country	Underlying policy rate	Monetary shock
US	Fed Funds Rate	$MP1_{US,t} = \frac{D}{D-d}\Delta f1_t$
AU	SFE 90-Day Bank Accepted Bill Rate	$MP_{AU,t} = \Delta f1_{AU,t}$
CAN	ME 90-day Bankers' Acceptance Rate	$MP_{CAN,t} = \Delta f1_{CAN,t}$

Timing, Level, and Slope for AU and CAN

- For country $c \in \{AU, CAN\}$

$$MP_{c,t} = \alpha_1 + \beta_1 level_{c,t} + timing_{c,t}$$

$$\Delta c3MT_t = level_{c,t}$$

$$\Delta c2YT_t = \alpha_2 + \beta_2 level_{c,t} + \gamma_2 timing_{c,t} + slope_{c,t}$$

- $\Delta c3MT_t$ and $\Delta c2YT_t$ are changes in 3-month and 2-year c Treasuries 15 minutes *prior* to and 45 minutes *after* the announcement

Descriptive Statistics: Monetary Shocks (in percent)

	Mean	SD	p5	p25	Median	p75	p95	Events (S)
$timing_{US}$	9.6e-11	.044	-.077	-.006	.00067	.0088	.081	184
$level_{US}$	-.021	.14	-.16	-.016	-.0025	.005	.11	185
$slope_{US}$	5.3e-11	.07	-.12	-.029	.004	.033	.11	184

Fed scheduled announcements from 2/1994 - 12/2016.

	Mean	SD	p5	p25	Median	p75	p95	Events (S)
$timing_{CAN}$	2.2e-12	.0089	-.012	-.0052	-.00021	.0048	.012	130
$level_{CAN}$	.0005	.02	-.03	-.01	0	.01	.03	130
$slope_{CAN}$	2.8e-10	.18	-.12	-.048	-.016	.019	.11	130

BoC scheduled announcements from 12/2000 - 12/2016

	Mean	SD	p5	p25	Median	p75	p95	Events (S)
$timing_{AU}$	-.00013	.019	-.027	-.0065	.0011	.0086	.021	255
$level_{AU}$	.0026	.052	-.06	-.01	0	.02	.05	255
$slope_{AU}$	.00028	.069	-.12	-.025	.0027	.035	.11	222

RBA scheduled announcements from 3/1990 - 12/2016

GDP-Mimicking

- Our approach attempts to bridge the gap between monetary policy and asset prices (observed at high-frequency) and real variables like rGDP growth (observed at low-frequency).
- We do so by constructing a high-frequency analogue of rGDP "news" based on a systematic relationship between rGDP growth and asset returns.
    1. Regress changes in rGDP growth on a set of concurrent base asset returns.
    2. Construct high-frequency analogue of rGDP growth using loadings from **1.**, and base asset returns around monetary announcements.
    3. Regress high-frequency analogue of rGDP growth on monetary shocks

Intuition of GDP-Mimicking

- Key assumption of GDP-mimicking is that movements in base asset returns around monetary announcements convey information about the effect of monetary policy on the real economy, **through asset prices**.
- Directly regressing rGDP growth on monetary shocks is problematic as there are various confounding factors (productivity shocks, global risk, etc).
- Given a portfolio of assets that can replicate rGDP, changes in GDP-mimicking portfolio returns around monetary announcements can be used to predict "news" about future rGDP.

Step 1: GDP-Mimicking approach

- Denote rGDP growth over k-quarters, $y_{t+k} - y_t$, as $\tilde{y}_{t+k}$, and the concurrent change in base asset returns as $R_{t,t+k}$.

$$\tilde{y}_{t+k} = \gamma_1 R_{1,t+k} + \gamma_2 R_{2,t+k} + \ldots + \gamma_j R_{j,t+k} + u_t$$

- To optimize the replicating portfolio, we use a wide range of assets, comprising commodity futures and indices, exchange rates, stock indices, treasury yields, corporate and bond spreads, etc.

Step 2: High-Frequency GDP Portfolio

- We mimic real output growth at various horizons as a function of unexpected innovations to base asset returns around monetary announcements, using the *predicted weights* $\hat{\gamma}_1, \hat{\gamma}_2, ..., \hat{\gamma}_j$.
- The high-frequency analogue of rGDP we construct is denoted as $\tilde{y}^m_{t+k}$.

$$\tilde{y}^m_{t+k} = \hat{\gamma}_1 \tilde{R}^m_{1,t} + \hat{\gamma}_2 \tilde{R}^m_{1,t} + ... + \hat{\gamma}_j \tilde{R}^m_{j,t}$$

Step 3: Response of High-Frequency GDP to Monetary Policy

- The high-frequency analogue of rGDP can be directly regressed on the **timing**, **level** and **slope** monetary shocks.

$$\tilde{y}^m_{t+k} = \Phi_1 level_{i,t} + \Phi_2 timing_{i,t} + \Phi_3 slope_{i,t}$$

Robustness

- The more general criticism of our approach is whether our GDP-mimicking return is a representative component of rGDP "news" related to monetary policy.
- First, adjusted R^2 of the GDP-mimicking portfolio is sufficiently high enough - capturing sufficient unconditional variation.
- Second, tests of the out-of-sampling fit of our replicating portfolio show sufficient stability in coefficients.

Data

- **rGDP**: FRED and OECD
- **Corporate bond indices, Commodity indices**: Global Financial Data (GFD), Bloomberg, Datastream
- **High-frequency asset returns**: Thomson Reuters Tick History (TRTH) and CQG.
- In selecting the base assets for the analysis, we begin with an unfiltered list of exchange rates, stock indices, commodity indices, etc. for each country.
- Variables are optimally selected based on maximizing the adjusted R^2 of the in-sample fit.

Replicating Portfolio: US

Currency	Stock Indices	Commodities	Bond Yields/Other
eur/usd	S&P500	ICE Brent Crude Oil	T 3m,6m,2Y,5Y,10Y,30Y
gbp/usd	S&P Banks	NY MEX Nat Gas	T 10Y-2Y, 30Y-2Y
cny/usd	S&P Retail	COMEX Gold	Corp, 1-10Y
mxn/usd	S&P Healthcare	COMEX Silver	Corp, 10+Y
	S&P Industrials	S&P GSCI Agr	S&P 500 VIX
	S&P Financials	S&P GSCI Livestock	ML 1m-vol MOV
	DJ Transports	S&P GSCI TR	
	DJ Banks	S&P GSCI Pmetals	
	DJ Utilities	S&P GSCI Imetals	
	DJ Oil & Gas		
	DJ Real Estate Index		
	Russell 2000		
	Nasdaq Composite 100		

Replicating Portfolio: Canada

Currency	Stock Indices	Commodities	Bond Yields/Other
cadusd	CDNX Comp, TSX300 Comp	ICE Brent Crude Oil	T 3m,6m,2Y,5Y,10Y,30Y
cadeur	TSX300 Comp	NY MEX Nat Gas	T 10Y-2Y, 30Y-2Y
cadcny	TSX60 Large Cap	COMEX Gold	Corp, 1-10Y, 5-10Y, 15Y
cadjpy	TSX Banks	COMEX Silver	Corp, 10+Y
cadmxn	TSX Gold	S&P GSCI Agr	S&P 500 VIX
	TSX60 Large Cap	S&P GSCI Livestock	ML 1m-vol MOV
	TSX Energy	S&P GSCI TR	
	TSX IT	S&P GSCI Pmetals	
	TSX Materials	S&P GSCI Imetals	
	TSX Consumer Disc		

Replicating Portfolio: Australia

Currency	Stock Indices	Commodities	Bond Yields
audusd	ASX200 All Ord	ICE Brent Crude Oil	T 3m,2y,5y,10y,15y
audjpy	ASX50 Large Cap	NY MEX Nat Gas	T 10Y-2Y, 15Y-2Y
audeur	ASX50 Mid Cap	COMEX Gold	Corp, 1-10Y
audgbp	ASX200 Small Ord	COMEX Silver	Corp, All maturities
	ASX200 Banking	S&P GSCI Agr	
	ASX200 Energy	S&P GSCI Livestock	
	ASX200 Utilities	S&P GSCI TR	
	ASX200 Materails	S&P GSCI Pmetals	
	ASX200 Small Ord	S&P GSCI Imetals	

adjusted R^2 and RMSE of first-stage regressions

Country		k=1	k=2	k=4	k=6	k=8	k=10	k=12
US	$\overline{R}^2$	.61	.77	.91	.96	.98	.98	.99
	RMSE	.72	.95	.66	.54	.86	.75	.79
	N	88	87	85	83	81	79	77
Canada	$\overline{R}^2$	.5	.8	.94	.94	.98	.97	.98
	RMSE	.71	.79	.55	.5	.73	.7	.23
	N	77	76	74	72	70	68	66
Australia	$\overline{R}^2$	.4	.54	.8	.9	.89	.93	.94
	RMSE	.6	.92	.87	.84	1.8	1.5	1.2
	N	82	81	79	77	75	73	71

US Asset HF Responses to US MP Shocks

	S&P500	EUR/USD	$TERM^{US,10\text{-}2Yr}$	S&P500 Vol	S&P GSCI TR
$timing_{US}$	-5.7***	-2.7***	-.35**	6.5***	-3
	(-3.5)	(-2.8)	(-2.2)	(2.9)	(-1.2)
$level_{US}$	1	-.35*	-.059**	-1.2	.33
	(1.1)	(-1.8)	(-2.2)	(-1.2)	(.69)
$slope_{US}$	-1.2	-2.3***	-.36***	.48	-2.8*
	(-1.1)	(-3.8)	(-3.1)	(.39)	(-1.8)
R^2	.14	.14	.19	.1	.027
Events	168	183	184	168	184

t-statistics in parentheses

Heteroscedasticity-consistent and robust standard errors.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

CAN Asset HF Responses to CAN MP Shocks

	MSCI-Can ETF	CAD/USD	$TERM^{CA,10\text{-}2Yr}$	S&P GSCI TR
$timing_{CAN}$	16	4.8	-1.8**	-13
	(.89)	(.96)	(-2.2)	(-1)
$level_{CAN}$	9.1	2.6	-.91*	12**
	(1.4)	(1.3)	(-1.8)	(2.2)
$slope_{CAN}$	-.59*	.47	-1.9***	-.75***
	(-1.8)	(.8)	(-10)	(-2.7)
R^2	.041	.051	.93	.041
Events	130	129	130	130

t-statistics in parentheses

Heteroscedasticity-consistent and robust standard errors.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

AU Asset HF Responses to AU MP Shocks

	ASX50 MCap	AUD/USD	$SPREAD^{AU,allYr}$	S&P GSCI TR
$timing_{AU}$	-1.1	-.97	.68	.88
	(-.32)	(-.2)	(1.6)	(.1)
$level_{AU}$	-1.3	-.18	-.12	.21
	(-.88)	(-.09)	(-1.1)	(.038)
$slope_{AU}$	-2***	3.1***	.25**	-.56
	(-3.1)	(3.1)	(2.5)	(-.31)
R^2	.097	.074	.21	.00079
Events	222	222	211	222

t-statistics in parentheses

Heteroscedasticity-consistent and robust standard errors.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

CAN Asset HF Responses to US MP Shocks

	MSCI-Can ETF	CAD/USD	$TERM^{CA,10\text{-}2Yr}$	S&P GSCI TR
$timing_{US}$	-9.5***	-2.5***	-.32***	-3
	(-4.4)	(-3.7)	(-3.3)	(-1.2)
$level_{US}$	.38	-.066	-.043	.33
	(.44)	(-.57)	(-1.2)	(.69)
$slope_{US}$	-1.8	-1.9***	-.099*	-2.8*
	(-1.3)	(-3.3)	(-1.7)	(-1.8)
R^2	.15	.12	.016	.027
Events	167	183	168	184

t-statistics in parentheses

Heteroscedasticity-consistent and robust standard errors.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

AU Asset HF Responses to US MP Shocks

	ASX50 MCap	AUD/USD	$SPREAD^{AU,allYr}$	S&P GSCI TR
$timing_{US}$	-.048	-2.8***	-.013	-3
	(-.11)	(-2.8)	(-.13)	(-1.2)
$level_{US}$	-.0088	-.3*	-.071*	.33
	(-.095)	(-1.7)	(-2)	(.69)
$slope_{US}$	-.18	-3.1***	.0027	-2.8*
	(-1.3)	(-3.9)	(.063)	(-1.8)
R^2	.0085	.13	.039	.027
Events	168	183	160	184

t-statistics in parentheses

Heteroscedasticity-consistent and robust standard errors.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

US GDP-Mimicking portfolio: Response to US MP Shocks

	k=1	**k=2**	**k=4**	**k=6**	**k=8**	**k=10**	**k=12**
$timing_{US}$	-1.2	-.85	-.67	-1.6	.3	-1.5	.057
	(-1.2)	(-.87)	(-.83)	(-1.1)	(.62)	(-1.3)	(.1)
$level_{US}$	-.13	-.21*	-.2**	-.39**	.022	-.092	.079
	(-1.1)	(-1.8)	(-2.2)	(-2.3)	(.26)	(-.71)	(.84)
$slope_{US}$	-1.5**	-1.4**	-1.1**	-1.9*	.075	-1.6**	-.54
	(-2.1)	(-2)	(-2.1)	(-1.7)	(.27)	(-2.3)	(-1.6)
R^2	.032	.029	.03	.021	.0034	.042	.017
Events	184	184	184	184	184	184	184

t-statistics in parentheses

Heteroscedasticity-consistent and robust standard errors.

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

CAN GDP-Mimicking portfolio: Responses to CAN MP Shocks

	k=1	k=2	k=4	k=6	k=8	k=10	k=12
$timing_{CAN}$	-.09	-2.6	2.1	-2.2	-.097	-4.3**	-1.5
	(-.11)	(-1.5)	(.91)	(-1.2)	(-.038)	(-2.1)	(-.97)
$level_{CAN}$	-.31	-.72	-2.2	-1.5	-3.6	-1.5	.56
	(-.71)	(-.6)	(-1.2)	(-1.2)	(-1.5)	(-1.3)	(.71)
$slope_{CAN}$	.037	-2.1***	.22*	-1.4***	-1.3***	-2.3***	-1.5***
	(.78)	(-6.3)	(1.7)	(-7.2)	(-3.9)	(-7.3)	(-6.6)
R^2	.016	.73	.021	.48	.23	.73	.79
Events	130	130	130	130	130	130	130

t-statistics in parentheses

Heteroscedasticity-consistent and robust standard errors.

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

AU GDP-Mimicking News: Responses to AU MP Shocks

	k=1	k=2	k=4	k=6	k=8	k=10	k=12
$timing_{AU}$	-1.7	-3.6*	-.31	-1.4	-1.1	-2	-.25
	(-1.2)	(-1.8)	(-.33)	(-1.2)	(-.72)	(-1)	(-.19)
$level_{AU}$	-.41	-.55	.028	-1.1	-1.1	-1.5	-1.1
	(-.56)	(-.44)	(.057)	(-1.2)	(-.92)	(-.86)	(-1.4)
$slope_{AU}$	-.69*	-1.2*	-.088	-1.3***	-1.2***	-1.7**	-.72***
	(-1.8)	(-2)	(-.45)	(-3.7)	(-2.6)	(-2.5)	(-2.6)
R^2	.027	.027	.0012	.051	.025	.021	.046
Events	222	222	222	222	222	222	222

t-statistics in parentheses

Heteroscedasticity-consistent and robust standard errors.

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

CAN GDP-Mimicking News: Responses to US MP Shocks

	k=1	k=2	k=4	k=6	k=8	k=10	k=12
$timing_{US}$	.87**	1.2*	.69	1.1	.78	.29	.3
	(2.2)	(1.9)	(.79)	(1.4)	(.63)	(.61)	(1.6)
$level_{US}$	-.017	-.018	-.21*	.15	-.32**	.095	.026
	(-.28)	(-.17)	(-1.9)	(1.3)	(-2)	(1.4)	(.55)
$slope_{US}$	.38	.93*	-.12	1.1**	-.27	.37	.24**
	(1.2)	(1.9)	(-.18)	(2.1)	(-.27)	(1.3)	(2.2)
R^2	.056	.033	.0068	.03	.008	.0068	.022
Events	184	184	184	184	184	184	184

t-statistics in parentheses

Heteroscedasticity-consistent and robust standard errors.

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

AU GDP Mimicking News: Responses to US MP Shocks

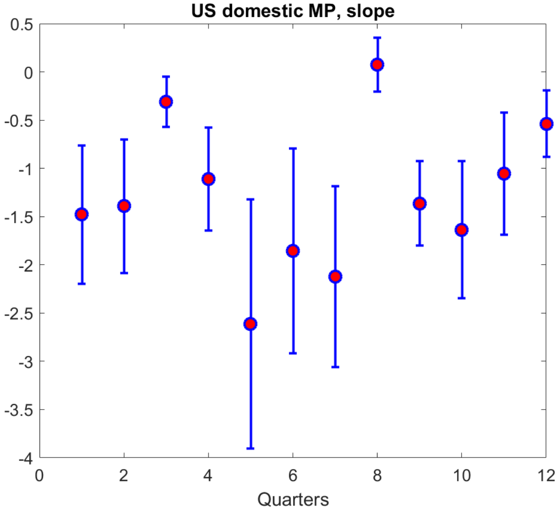
	k=1	k=2	k=4	k=6	k=8	k=10	k=12
$timing_{US}$	.46	1.1	-.28	.08	1.3	1.6	-.65
	(.56)	(.67)	(-.62)	(.071)	(.9)	(.71)	(-.99)
$level_{US}$	-.15**	-.27**	-.34***	-.28***	-.29**	-.24	-.31**
	(-2.4)	(-2.4)	(-3.5)	(-2.7)	(-2.1)	(-1.5)	(-2.4)
$slope_{US}$	.27	.47	-.74**	-.15	.5	1.1	-.81*
	(.71)	(.66)	(-2.4)	(-.28)	(.77)	(1.1)	(-2)
R^2	.0085	.0093	.056	.0056	.013	.012	.038
Events	184	184	184	184	184	184	184

t-statistics in parentheses

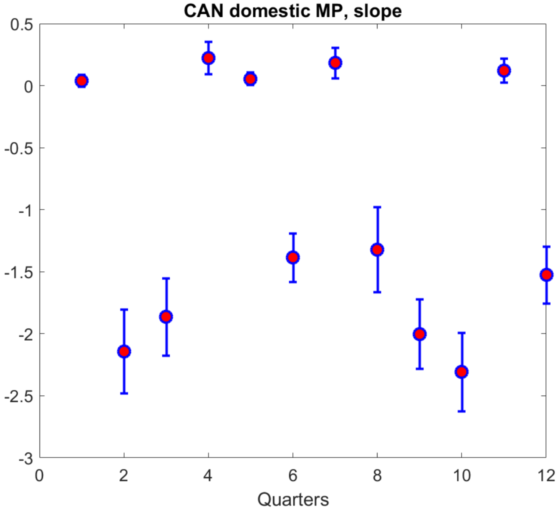
Heteroscedasticity-consistent and robust standard errors.

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

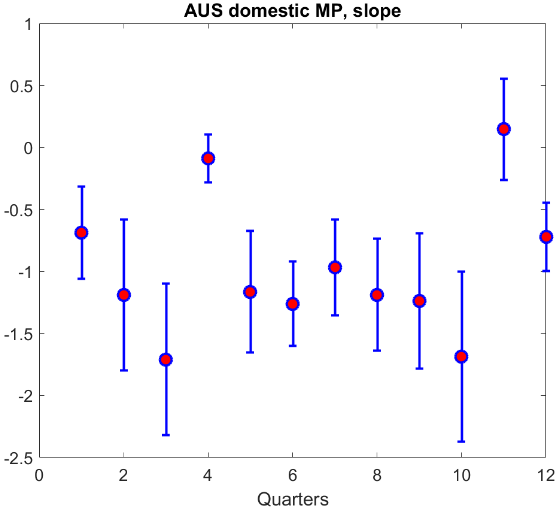
US GDP-Mimicking portfolio: Response to US **Slope** Shock



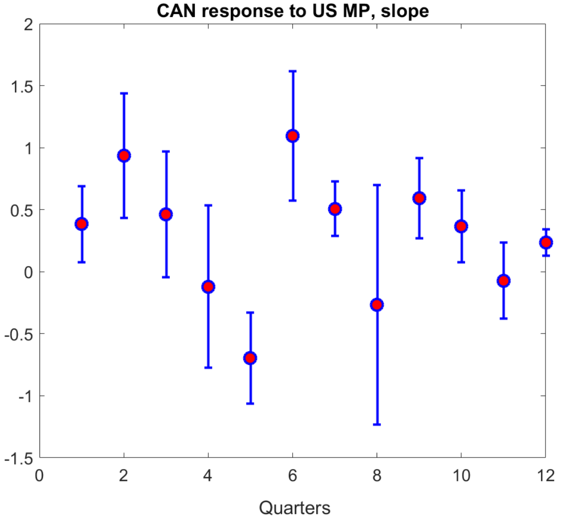
CAN GDP-Mimicking portfolio: Response to CAN **Slope** Shock



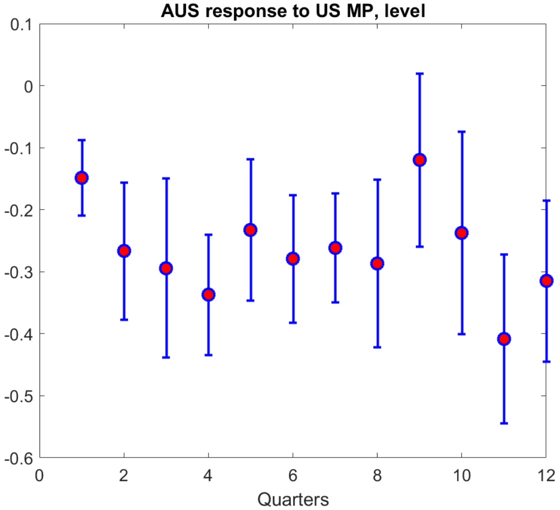
AU GDP-Mimicking portfolio: Response to AU **Slope** Shock



CAN GDP Mimicking portfolio: Response to US **Slope** Shock



AU GDP-Mimicking portfolio: Response to US **Level** Shock



Conclusion

- Overall, US, AU, and CAN domestic policy shocks are *contractionary* at home. Mixed evidence of US monetary spillovers abroad.
- Next steps include
  - Variance decompose the rGDP-mimicking portfolio return response around monetary announcements along the lines of Bernanke and Kuttner (2005): "news" from discount rates, cash-flows, or excess risk premia.
  - Test if international monetary policy spillovers manifested themselves *differently* via unconventional monetary policies following the financial crisis of 2007.