FX Interventions, Market Expectations, and Risk Premia

Christiane Baumeister[1,2] Nelson C. Mark[1,3]
Daniel M. Mershon[1]

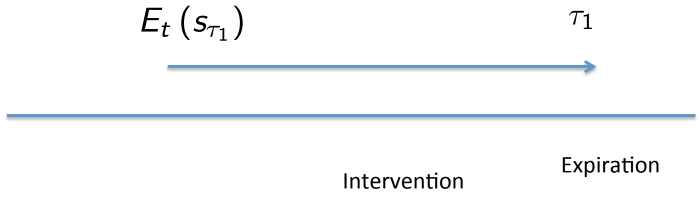
[1] University of Notre Dame, Department of Economics

[2]CEPR

[3]NBER

December 8, 2017

The Idea



1. We conduct an **event study** whether/how FX intervention change market **expectations** of future spot at a **fixed** future date.
2. Most interventions are sterilized. What do they accomplish?
   - Signaling hypothesis
   - Portfolio balance
3. Both views consistent with changing market expectation of the future spot.
4. Evidence on effectiveness remains mixed.

Preview of results

In response to FX interventions:

1. **Market's expectations**
    - Market revises expectation of future spot by 180 bp
    - Magnitude: 0.85 standard deviations
    - Direction of change consistent with direction of intervention (80% success)
2. **Risk Premia**
    - RP changes by 80 bp
    - Magnitude: 2.5 standard deviations
3. **Uncertainty**
    - RP changes less consistent with direction of intervention (60%)
    - Large changes in RP (i.e., not "normal"): 80% (mostly positive changes)

Roadmap

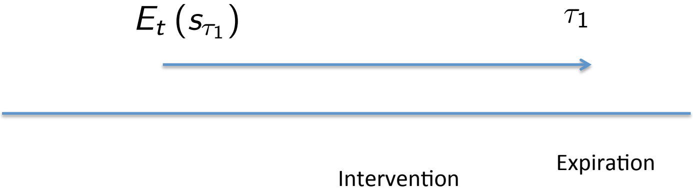
1. Motivate project with signaling hypothesis
2. Measure expectations
3. Event study with synthetic controls
4. Report Empirical Results

Signaling Hypothesis

I models of exchange rate,

$$s_t = E_t \sum_{j=0}^{\infty} \delta^j \mathscr{F}_{t+j}$$

$$E_t s_{\tau_1} = E_t \sum_{j=0}^{\infty} \delta^j \mathscr{F}_{\tau_1+j}$$



Measuring Expectations

1. Risk-adjust (log) futures prices to get market expectations

$$f_{\tau_1,t} = E_t s_{\tau_1} + \mathrm{rp}_{\tau_1,t}$$

2. Expectations become the basic observations.

Hamilton-Wu's Affine Term Structure Model

1. Mean-variance optimizer
2. Two dynamic latent factors.
3. FX futures are affine functions of factors.
4. Produces beta-risk representation for futures returns,

$$E_t\left(f_{h-1,t+1} - f_{h,t}\right) = \beta'_{h-1}\lambda_t \tag{1}$$

where β_{h-1}, and λ_t are functions of structural parameters.

5. Estimate the structural parameters, get the implied risk premia.

Event Study

Observe 3 interventions for **a given central bank**

— —

1 2 3

In event time, $Y^{I}_{i,t} = E_{t,I}\left(s_{\tau_1}\right)$
For intervention $i = 1$,

$$\underbrace{Y^{I}_{1,1}, Y^{I}_{1,2}, \ldots Y^{I}_{1,\tau_0}}_{\text{Pre-event}}; \underbrace{Y^{I}_{1,\tau_{0+1}}}_{\text{Event}} \underbrace{Y^{I}_{1,\tau_0+2}, \ldots, Y^{I}_{1,\tau_1}}_{\text{Post-event}}$$

Synthetic Control

$$\underbrace{Y^I_{1,1},\ Y^I_{1,2}, \dots Y^I_{1,\tau_0}}_{\text{Pre-event}};\ \underbrace{Y^I_{1,\tau_{0+1}}}_{\text{Event}}\ \underbrace{Y^I_{1,\tau_0+2}, \dots,\ Y^I_{1,\tau_1}}_{\text{Post-event}}$$

Other windows of length τ_1, but **no interventions** $Y^N_{j,t} = E_{t,N}\left(s_{\tau_1}\right)$

$$Y^N_{1,1},\ Y^N_{1,2}, \dots Y^N_{1,\tau_0};\ Y^N_{1,\tau_{0+1}}\ Y^N_{1,\tau_0+1}, \dots,\ Y^N_{1,\tau_1}$$

$$Y^N_{2,1},\ Y^N_{2,2}, \dots Y^N_{2,\tau_0};\ Y^N_{2,\tau_{0+1}}\ Y^N_{2,\tau_0+2}, \dots,\ Y^N_{2,\tau_1}$$

$$\vdots$$

$$Y^N_{n,1},\ Y^N_{n,2}, \dots Y^N_{n,\tau_0};\ Y^N_{n,\tau_{0+1}}\ Y^N_{n,\tau_0+2}, \dots,\ Y^N_{n,\tau_1}$$

Synthetic Control

$$\underbrace{Y^I_{1,1},\, Y^I_{1,2},\, \dots Y^I_{1,\tau_0}}_{\text{Pre-event}};\, \underbrace{Y^I_{1,\tau_{0+1}}}_{\text{Event}}\, \underbrace{Y^I_{1,\tau_0+2},\, \dots,\, Y^I_{1,\tau_1}}_{\text{Post-event}}$$

Associate weights ω to non-intervention samples. Will choose to mimic pre-intervention observations

$$\begin{array}{ll} \omega_1 & Y^N_{1,1},\, Y^N_{1,2},\, \dots Y^N_{1,\tau_0};\, Y^N_{1,\tau_{0+1}}\, Y^N_{1,\tau_0+1},\, \dots,\, Y^N_{1,\tau_1} \\ \omega_2 & Y^N_{2,1},\, Y^N_{2,2},\, \dots Y^N_{2,\tau_0};\, Y^N_{2,\tau_{0+1}}\, Y^N_{2,\tau_0+2},\, \dots,\, Y^N_{2,\tau_1} \\ & \vdots \\ \omega_n & \underbrace{Y^N_{n,1}}_{\omega' Y^N_{[\cdot,1]}},\, \underbrace{Y^N_{n,2}}_{\omega' Y^N_{[\cdot,2]}},\, \dots\, \underbrace{Y^N_{n,\tau_0}}_{\omega' Y^N_{[\cdot,\tau_0]}};\, Y^N_{n,\tau_{0+1}}\, Y^N_{n,\tau_0+2},\, \dots,\, Y^N_{n,\tau_1} \end{array} \quad (2)$$

$$\overbrace{Y^I_{1,1},\, Y^I_{1,2}, \ldots Y^I_{1,\tau_0}}^{X_1'}\!\underbrace{Y^I_{1,1},\, Y^I_{1,2}, \ldots Y^I_{1,\tau_0}}_{\text{Pre-event}};\, \underbrace{Y^I_{1,\tau_0+1}}_{\text{Event}}\, \underbrace{Y^I_{1,\tau_0+2}, \ldots,\, Y^I_{1,\tau_1}}_{\text{Post-event}} \tag{3}$$

$$X_1 = \begin{pmatrix} Y^I_{1,1} \\ \vdots \\ Y^I_{1,\tau_0} \end{pmatrix} \quad X_0 = \begin{pmatrix} Y^N_{1,1} & \cdots & Y^N_{n,1} \\ \vdots & & \vdots \\ Y^N_{1,\tau_0} & \cdots & Y^N_{n,\tau_0} \end{pmatrix} \tag{4}$$

Choose ω to minimize

$$(X_1 - X_0\omega)'\, V\, (X_1 - X_0\omega) \tag{5}$$

s.t. $\omega'\iota = 1,\ \omega_j \geq 0,\ V$, is symmetric, p.d.
Single path comparison, $\alpha^I_{1,t} = Y^I_{1,t} - \omega' Y^N_{[\cdot,t]}$
Distribution under the null: $\alpha^N_{j,t} = Y^N_{j,t} - \omega' Y^N_{[\cdot,t]},\ j = 1, \ldots, n.$

Data inputs

Data inputs for each step

1. Measuring expectations
   - Weekly FX futures prices for 5+ consecutive years
   - Bilateral weekly spot prices
2. Event study
   - Daily FX intervention data from central bank

Goal: Broadest coverage possible (without sacrificing data quality)

Final sample: 9 countries, 70+ intervention epsiodes

Sample

Table 1: FX intervention data and coverage

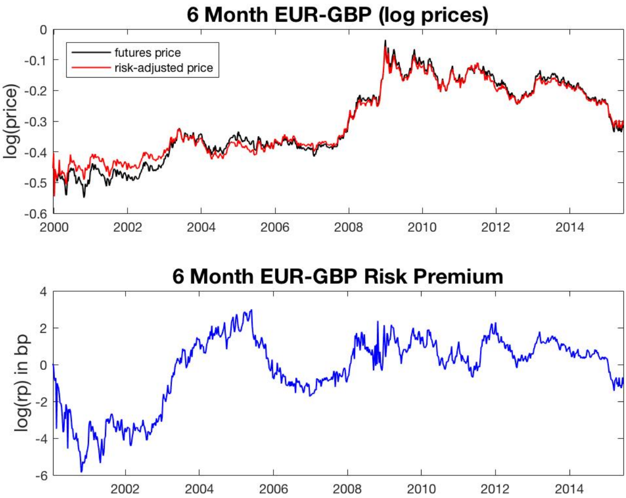
Country / Area	Source	Currencies	Frequency	Intervention Data	Futures
Australia	FRED	AUD-USD	Daily	1983-2016	1992-2015
Canada	On request	CAD-USD	Daily	1970-2011	1979-1999
ECB	Website	EUR-USD	Daily	1999-2016	1999-2016
Japan	FRED	JPY-USD	Daily	1991-2015	1986-2015
Poland	Website	PLN-EUR	Daily	2004-2015	2004-2016
Switzerland	FRED	CHF-USD, JPY-USD	Daily	1975-2001	1986-2015
Turkey	FRED	USD-TRY	Daily	2002-2015	2005-2016
United Kingdom	On request	EUR-GBP, GBP-JPY, GBP-USD, JPY-USD	Daily	1977-2016	1999-2016, 1998-2013 1990-2015, 1986-2015
United States	FRED	EUR-USD, JPY-USD	Daily	1973-2016	1999-2016, 1986-2015

Evaluating $E_t s_{t+h}$

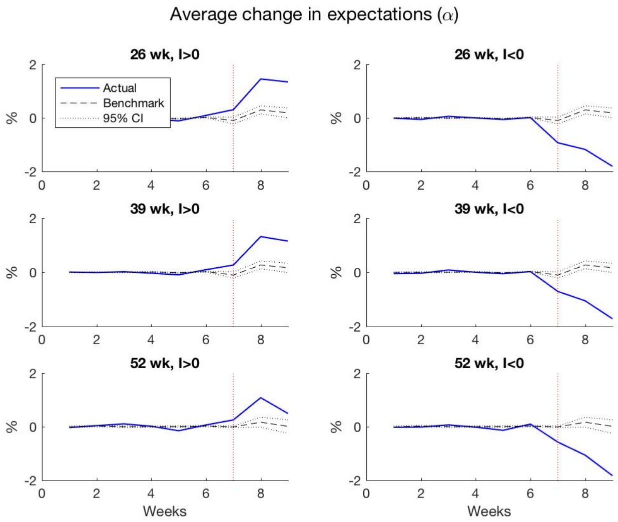
Table 2: MSPE ratios

		Risk-adjusted			Futures price		
Exchange Rate	Period	13 wk	26 wk	39 wk	13 wk	26 wk	39 wk
AUD-USD	1992 to 2015	**0.940***	**0.895****	**0.819****	1.042	1.063	1.103
CAD-JPY	2009 to 2016	**0.981**	**0.944**	**0.917**	1.030	1.069	1.100
CAD-USD	1979 to 1999	**0.990*****	**0.868*****	**0.761*****	1.138	1.162	1.188
CHF-USD	1992 to 2015	**0.993**	**0.941***	**0.860****	1.019	1.036	1.063
EUR-CAD	2004 to 2016	**0.826****	**0.678****	**0.638*****	1.007	1.000	**0.982**
EUR-GBP	1999 to 2016	**0.959*****	**0.925****	**0.867****	**0.969***	**0.956***	**0.933***
EUR-JPY	2009 to 2016	**0.995**	**0.993****	**0.989***	**0.991**	**0.982**	**0.971***
EUR-USD	1999 to 2016	1.074	1.000	**0.945**	1.024	1.033	1.041
GBP-JPY	1998 to 2013	**0.968**	**0.952**	**0.942**	**0.948**	**0.939**	**0.934**
GBP-USD	1990 to 2015	**0.900****	**0.812****	**0.781****	**0.959**	**0.946**	**0.944**
JPY-USD	1986 to 2016	**0.930*****	**0.838*****	**0.761*****	1.042	1.079	1.113
PLN-EUR	2004 to 2016	1.014	1.011	1.008	1.021	1.014	1.002
USD-TRY	2005 to 2016	**0.914***	**0.901***	**0.864***	**0.908***	**0.955**	1.002

Example: EUR-GBP



Effect on Expectations



Average treatment effect

Table 3: Average Change in $E_t s_{t+h}$

	Change in Expected Spot (in b.p.)			
Horizon	$I > 0$	$I < 0$	Baseline 95% CI	
26 wk	1.35	-1.80	0.02	0.35
39 wk	1.16	-1.72	0.00	0.32
52 wk	0.48	-1.82	-0.23	0.22

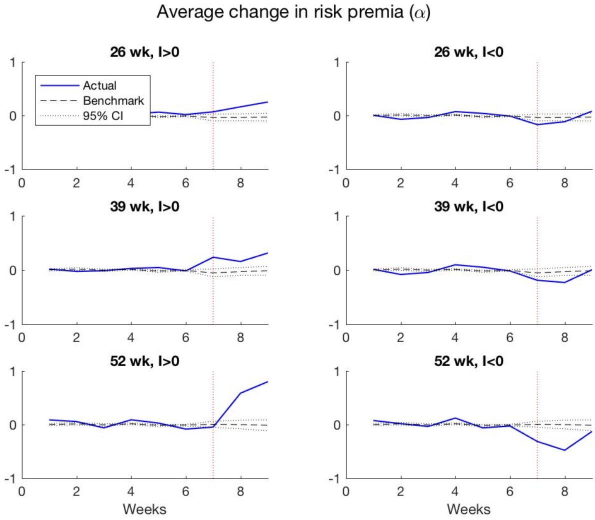
Intervention causes 1 stdev change in expected spot price

Directional criteria

Table 4: $E_t s_{t+h}$ Directional Criteria

	Criteria	Result	Null
T1	$I > 0$ ($I < 0$) and $\Delta E_t s_{t+h} > 0$ (< 0)	80	50
T2	T1 + statistically significant change	60	2.5
T3	Statistically significant change	59	5

Effect on Risk Premia



Average treatment effect

Table 5: Average Change in RP_{t+h}

	Change in Risk Premia (in b.p.)			
Horizon	$I > 0$	$I < 0$	Baseline 95% CI	
26 wk	0.23	0.08	-0.08	0.03
39 wk	0.31	0.00	-0.08	0.05
52 wk	0.78	-0.14	-0.10	0.07

Table 6: RP_{t+h} Directional Criteria

	Criteria	Result	Null
T1	$I > 0$ ($I < 0$) and $\Delta RP_{t+h} > 0$ (< 0)	58	50
T2	T1 + statistically significant change	48	2.5
T3	Statistically significant change	80	5

Summary & Conclusion

- Sterilized intervention can be a powerful policy instrument
- This paper provides strong support for the signaling hypothesis
- Despite leaving funamentals unchanged, FX interventions change spot prices by:
  - Affecting market expectations
  - Changing the equilibrium compensation of risk
  - Affecting certainty about future monetary policy

Comparing Forecast Errors

Example:

Table 7: Forecast errors for 26 week contract

Forecast Errors		
Futures	Risk-adjusted	Random-walk
$f_1^{26} - s_{26}$	$log(E_1 S_{26}) - s_{26}$	$s_1 - s_{26}$
$f_2^{25} - s_{26}$	$log(E_2 S_{26}) - s_{26}$	$s_2 - s_{26}$
$\vdots$	$\vdots$	$\vdots$
$f_{13}^{13} - s_{26}$	$log(E_{13} S_{26}) - s_{26}$	$s_{13} - s_{26}$

By country: $I > 0$, expected spot

Table 8: Expected spot price: average treatment effect by country

$I > 0$		Placebo				Placebo				Placebo		
Country	h = 6	95% CI		nobs	h = 9	95% CI		nobs	h = 12	95% CI		nobs
Australia	-1.25	-0.87	0.47	4	-1.34	-0.60	0.73	4	-2.42	-0.99	0.99	1
Canada	1.04	-0.30	0.10	8	0.77	-0.25	0.12	8	1.26	-0.41	0.41	4
ECB	-2.35	-0.62	0.49	1	-2.05	-0.69	0.39	1				0
Japan	0.66	-0.31	0.56	6	0.52	-0.27	0.53	6	0.93	-0.25	0.51	4
Poland				0				0				0
Switzerland	3.37	-0.20	0.43	6	2.92	-0.14	0.44	5	1.27	-0.62	0.20	4
Turkey	0.16	-0.89	1.59	1	0.47	-1.06	1.47	1	-1.33	-1.23	1.33	1
UK				0		-0.05	0.33	0				0
USA	2.70	-0.15	0.59	8	2.30	-0.13	0.55	8	0.94	-0.56	0.36	6
Total				34				33				20
Mean	0.62	-0.48	0.61		0.51	-0.36	0.63		0.11	-0.68	0.63	

By country: $I < 0$, expected spot

Table 9: Expected spot price: average treatment effect by country

$I < 0$ Country	h = 6	Placebo 95% CI		nobs	h = 9	Placebo 95% CI		nobs	h = 12	Placebo 95% CI		nobs
Australia	-0.25	-0.87	0.47	6	-0.33	-0.60	0.73	5	-0.24	-0.99	0.99	2
Canada	-0.79	-0.30	0.10	16	-0.70	-0.25	0.12	16	-0.61	-0.41	0.41	11
ECB				0				0				0
Japan	-1.31	-0.31	0.56	2	-0.84	-0.27	0.53	2	-0.21	-0.25	0.51	2
Poland	0.19	-0.12	1.01	2	0.14	-0.09	1.14	2	-0.29	-1.08	0.51	1
Switzerland	-8.58	-0.20	0.43	1	-7.73	-0.14	0.44	1	-7.19	-0.62	0.20	1
Turkey	-2.77	-0.89	1.59	1	-3.28	-1.06	1.47	1				0
UK	-1.16	-0.05	0.38	5	-1.18	-0.05	0.33	5	-2.44	-0.04	0.44	3
USA	-2.82	-0.15	0.59	5	-2.72	-0.13	0.55	5	-3.43	-0.56	0.36	3
Total				38				37				23
Mean	-2.19	-0.36	0.64		-2.08	-0.32	0.66		-2.06	-0.57	0.49	

By country, $I > 0$, RP

Table 10: Risk premia: average treatment effect by country

$I > 0$ Country	h = 6	Placebo 95% CI		nobs	h = 9	Placebo 95% CI		nobs	h = 12	Placebo 95% CI		nobs	ΔTP
Australia	0.20	0.04	0.49	3	0.61	0.01	0.54	3.00	0.84	-0.16	0.42	2	0.65
Canada	-0.31	-0.21	0.09	6	-0.24	-0.24	0.21	6.00	0.13	0.01	0.31	5	0.43
ECB	0.61	-0.19	0.05	1	-0.07	-0.20	0.08	1.00	1.11	-0.31	0.18	1	0.51
Japan	-0.06	-0.19	0.25	6	-0.07	-0.29	0.22	6.00	0.13	0.16	0.69	5	0.19
Poland				0				0.00				0	
Switzerland	0.56	-0.08	0.10	6	0.50	-0.10	0.12	6.00	0.05	-0.16	0.34	5	-0.51
Turkey	0.09	-0.53	0.10	1	0.06	-0.53	0.24	1.00	1.48	-0.70	1.39	1	1.39
UK				0				0.00				0	
USA	0.65	-0.52	0.10	8	0.89	-0.53	0.23	7.00	3.62	-0.70	1.37	4	2.96
Total				31				30				23	
Mean	0.25	-0.24	0.17		0.24	-0.27	0.24		1.05	-0.27	0.67		0.80

By country, $I < 0$, RP

Table 11: Risk premia: average treatment effect by country

$I < 0$ Country	h = 6	Placebo 95% CI		nobs	h = 9	Placebo 95% CI		nobs	h = 12	Placebo 95% CI		nobs	ΔTP
Australia	0.65	0.04	0.49	4	1.03	0.01	0.54	4.00	1.12	-0.16	0.42	3	0.47
Canada	-0.38	-0.21	0.09	15	-0.56	-0.24	0.21	15.00	-0.79	0.01	0.31	15	-0.41
ECB				0				0.00				0	
Japan	-0.08	-0.19	0.25	4	-0.27	-0.29	0.22	4.00	1.89	0.16	0.69	2	1.97
Poland	-0.30	-0.08	0.10	2	-0.43	-0.10	0.11	2.00	-0.50	-0.16	0.34	1	-0.20
Switzerland	1.74	-0.08	0.10	1	0.62	-0.10	0.12	1.00	-0.10	-0.16	0.34	1	-1.83
Turkey	1.24	-0.53	0.10	3	2.00	-0.53	0.24	3.00	1.33	-0.70	1.39	1	0.09
UK	-1.01	-0.51	0.11	6	-1.29	-0.54	0.24	6.00	-1.49	-0.70	1.39	6	-0.48
USA	0.53	-0.52	0.10	5	0.49	-0.53	0.23	5.00	0.38	-0.70	1.37	4	-0.15
Total				40				40				33	
Mean	0.30	-0.26	0.17		0.20	-0.29	0.24		0.23	-0.30	0.78		-0.07