Foreign Exchange Interventions, Exchange Rate Expectations, and Risk Premia

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

[1] University of Notre Dame, Department of Economics

[2]Natioanl Bureau of Economic Research

December 14, 2018

FX Interventions: Background

Central banks intervene in FX markets by purchasing/selling foreign currency

1. Practice has become more common recently (e.g., Swizterland, Israel, Denmark, Iceland, etc.)
2. Bank of Israel governer asks whether FXI should be considered "conventional" monetary policy

Unresolved Issues

1. Size of effects (endogeneity issue)
2. Likelihood of success
3. Persistence (generally thought to be ephemeral)
4. External validity of individual country experiences

Research Question

Question:
Do central bank FX interventions affect the market's expectations of future exchange rates?

Solution:
Use event-study approach to test if market revises expectations following intervention.

Short answer:
Yes. Market expects small but permanent change in spot price.

Solution

1. **A daily measure of market expectations**
   - Risk-adjusted futures prices: futures price = E[spot] + RP
   - Estimate RP from affine term-structure model (Hamilton & Wu 2014)
   - Assess expectations (Baumeister & Kilian 2016)
2. **Synthetic control**
   - Overcome potential endogeneity in event study
   - Construct counterfactuals via *synthetic control* method (Abadie et al 2010)
3. **Apply consistent methodology to broad coverage of countries**

Preview of results

In response to FX interventions:

1. **Market's expectations change**
   - Market revises expectation of future spot by 50 bp
   - Change expected to last for at least 1 year
   - Direction of change consistent with direction of intervention (70% success)
   - 24% cause at least 1 std change in correct direction
2. **Conditional on large FXI (0.005% GDP) & reinforcing 1 week spot price trend**:
   - Directional success rates up to 90%
   - Size of change: 80 bp ($\approx$ 1 std)
3. **Agents' willingness to bear risk changes**
   - RP changes up to 1 std
4. **Uncertainty about future spot price increases**
   - RP changes less consistent with direction of intervention (64%)
   - 60% cause at least 1 std change

Data inputs

Data inputs for each step

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

Goal: Broadest coverage possible (without sacrificing data quality)

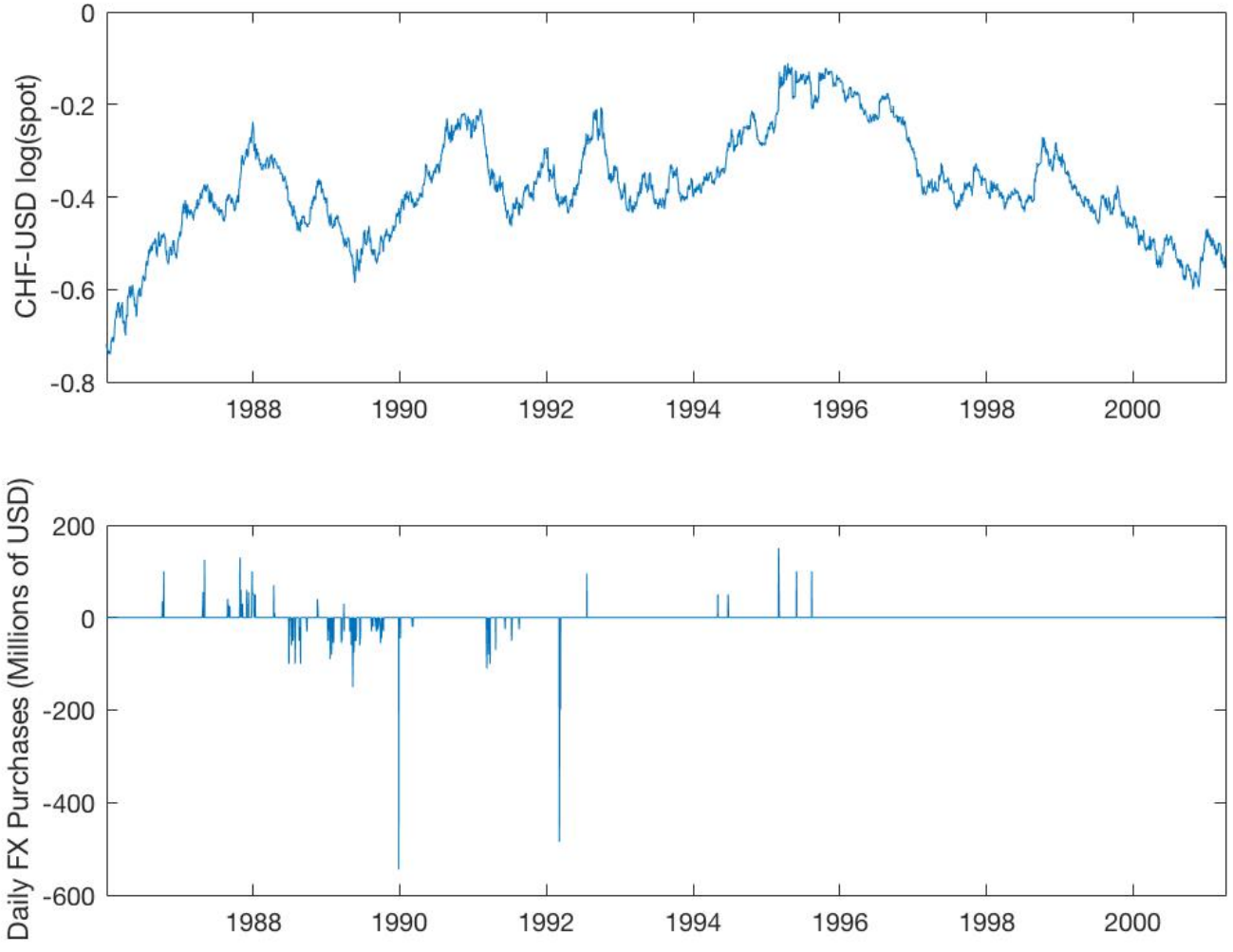
Final sample: 9 countries, ≈440 intervention epsiodes

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

Switzerland Interventions



Hamilton-Wu 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,

$$E_t\left(f_{t+1}^{h-1} - f_t^h\right) = \beta_{h-1}'\lambda_t$$

   where β_{h-1}, and λ_t are functions of structural parameters.
5. Estimate the structural parameters, get the implied risk premia.

Risk Adjustment:

$$E_t s_{t+h} = \tilde{f}_t^h = f_t^h - RP_{t+h}$$

BK Evaluation:

- In presence of risk premia, risk-adjusted futures price is conditional expectation of price $\Rightarrow$ minimizes MSPE

Evaluating $E_t s_{t+h}$

Table 2: Theil's U for Raw and Adjusted Futures Prices at Fixed Horizon, h week, Forecasts

		Risk-adjusted			Futures price		
Exchange Rate	Period	26 wk	39 wk	52 wk	26 wk	39 wk	52 wk
AUD-USD	1992 to 2015	**0.944***	**0.891****	**0.818****	1.037	1.058	1.096
CAD-JPY	2009 to 2016	**0.984**	**0.950**	**0.924**	1.024	1.059	1.090
CAD-USD	1979 to 1999	**0.968*****	**0.862*****	**0.763*****	1.132	1.162	1.189
CHF-USD	1992 to 2015	**0.991**	**0.942***	**0.865****	1.018	1.033	1.058
EUR-GBP	1999 to 2016	**0.948*****	**0.919****	**0.866****	**0.970***	**0.956***	**0.934***
EUR-JPY	2009 to 2016	**0.995**	**0.995****	**0.992***	**0.990**	**0.981**	**0.971***
EUR-USD	1999 to 2016	1.030	**0.975**	**0.925**	1.021	1.029	1.038
GBP-JPY	1998 to 2013	**0.957**	**0.942**	**0.931**	**0.947**	**0.937**	**0.932**
GBP-USD	1990 to 2015	**0.862****	**0.785****	**0.754****	**0.959**	**0.945**	**0.943**
JPY-USD	1986 to 2016	**0.909*****	**0.822*****	**0.749*****	1.038	1.074	1.106
PLN-EUR	2004 to 2016	1.010	1.008	1.006	1.016	1.012	1.002
USD-TRY	2005 to 2016	**0.925***	**0.913***	**0.880***	**0.919***	**0.962**	1.008

Example: EUR-GBP

Synthetic Control

In event time:

- $\tau_0 =$ length of pre-event window (days)
- $\tau_1 =$ length of post-event window
- $T = \tau_0 + \tau_1 =$ number of weeks surrounding the event.
- Vector "treated" by intervention:

$$Y = (\underbrace{\tilde{f}_1^h, \tilde{f}_2^{h-1}, ..., \tilde{f}_{\tau_0-1}^{h-\tau_0+2}, \tilde{f}_{\tau_0}^{h-\tau_0+1}}_{\text{Pre-intervention, } X'}, \underbrace{\tilde{f}_{\tau_0+1}^{h-\tau_0}, ..., \tilde{f}_{\tau_1}^{h-\tau_1+1}}_{\text{Post-intervention, } Z'})'$$

Synthetic Control

Suppose there are N available length T sequences of exchange rate expectations not affected by an intervention.

$$\mathbf{Y} = \begin{pmatrix} \underbrace{\begin{matrix} \tilde{f}^{h}_{1,1} & \cdots & \tilde{f}^{h-\tau_0+2}_{1,\tau_0-1} & \tilde{f}^{h-\tau_0+1}_{1,\tau_0} \\ \tilde{f}^{h}_{2,1} & \cdots & \tilde{f}^{h-\tau_0+2}_{2,\tau_0-1} & \tilde{f}^{h-\tau_0+1}_{2,\tau_0} \\ \vdots & \ddots & \vdots & \vdots \\ \tilde{f}^{h}_{N,1} & \cdots & \tilde{f}^{h-\tau_0+2}_{N,\tau_0-1} & \tilde{f}^{h-\tau_0+1}_{N,\tau_0} \end{matrix}}_{\text{Pre-intervention, } \mathbf{X}'} & \underbrace{\begin{matrix} \tilde{f}^{h-\tau_0}_{1,\tau_0+1} & \cdots & \tilde{f}^{h-\tau_1+1}_{1,\tau_1} \\ \tilde{f}^{h-\tau_0}_{2,\tau_0+1} & \cdots & \tilde{f}^{h-\tau_1+1}_{2,\tau_1} \\ \vdots & \ddots & \vdots \\ \tilde{f}^{h-\tau_0}_{N,\tau_0+1} & \cdots & \tilde{f}^{h-\tau_1+1}_{N,\tau_1} \end{matrix}}_{\text{Post-intervention, } \mathbf{Z}'} \end{pmatrix}'$$

$$= \begin{pmatrix} Y^1 \\ Y^2 \\ \vdots \\ Y^N \end{pmatrix}'$$

Synthetic Control

Choose $N \times 1$ vector of weights, W, to minimize the distance between X and $\mathbf{X} \cdot W$:

$$\begin{aligned} \min_{W} \quad & (X - \mathbf{X} \cdot W)' \mathbf{V} (X - \mathbf{X} \cdot W) \\ \text{s.t.} \quad & \sum_{i=1}^{N} w_i = 1 \\ & 0 \leq w_i \leq 1 \ \forall \ i \end{aligned} \tag{1}$$

Construct treatment effect:

$$\alpha = Y - \mathbf{Y} \cdot W$$

Or,

$$\begin{aligned} \alpha^{pre} &= X - \mathbf{X} \cdot W \approx 0 \\ \alpha^{post} &= Z - \mathbf{Z} \cdot W \end{aligned}$$

Null Distribution

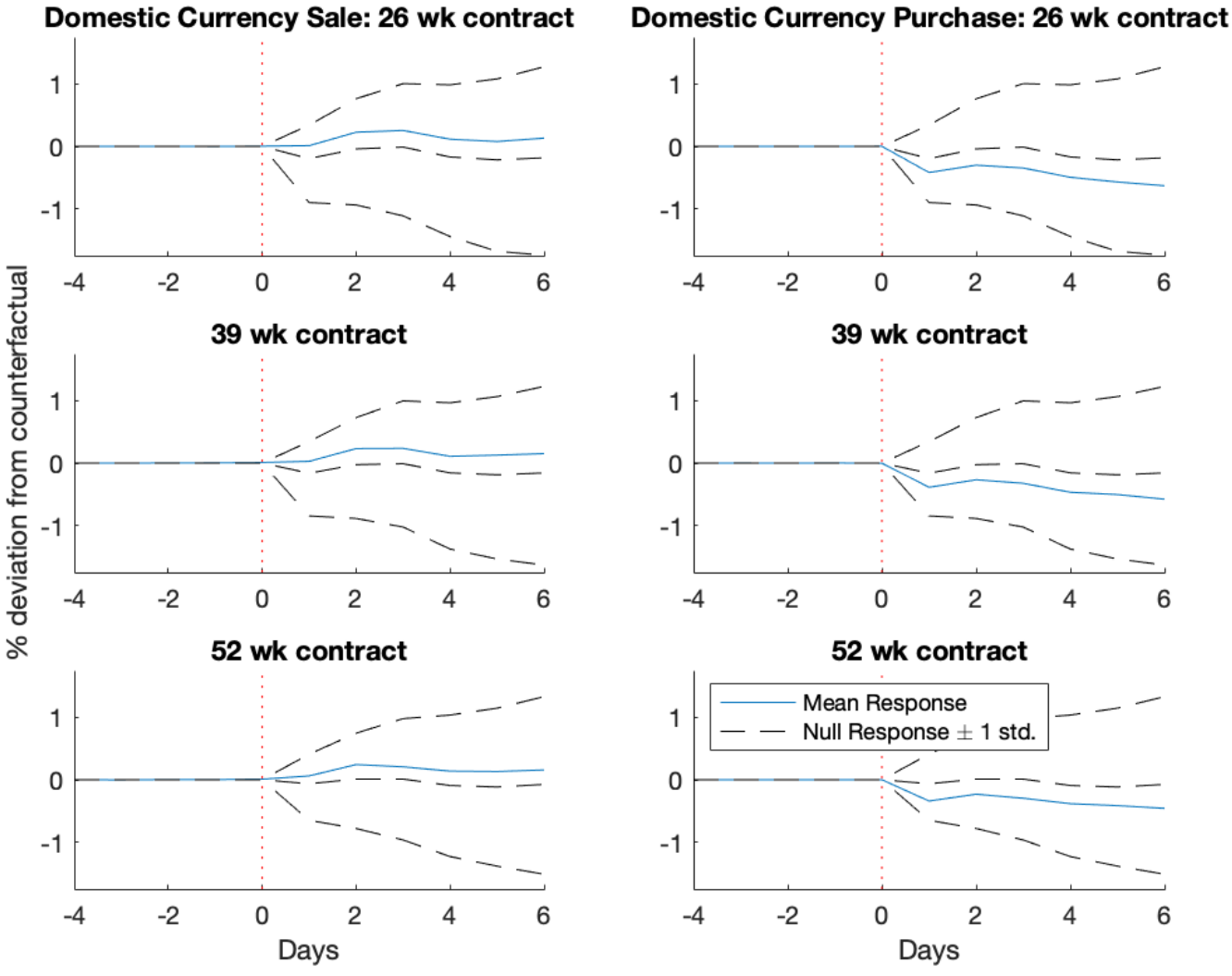
Construct baseline distribution of expectation sequences not affected by interventions.

1. Remove sequence Y^n, from $\mathbf{Y}$
2. Now have $T \times (N-1)$ matrix, $\mathbf{Y^n}$, otherwise identical to $\mathbf{Y}$, but column n removed
3. Generate a synthetic control for Y^n using $\mathbf{Y^n}$
4. Calculate deviations, α^n
5. Repeat for $n = 1, ..., N$ to get distribution of α's

Final steps:

- Repeat entire process for each intervention, each contract $h \in \{26, 39, 52\}$
- Construct $\bar{\alpha}$ by averaging over all interventions

Effect on Expectations



Average treatment effect

Table 3: Peak Response in Expected Spot Price

h	FX Purch	FX Sale
26	0.25	-0.63
39	0.24	-0.58
52	0.24	-0.46

Small but permanent change in expected spot price

Success Criteria

Table 4: Success Rates for Affecting Expectations

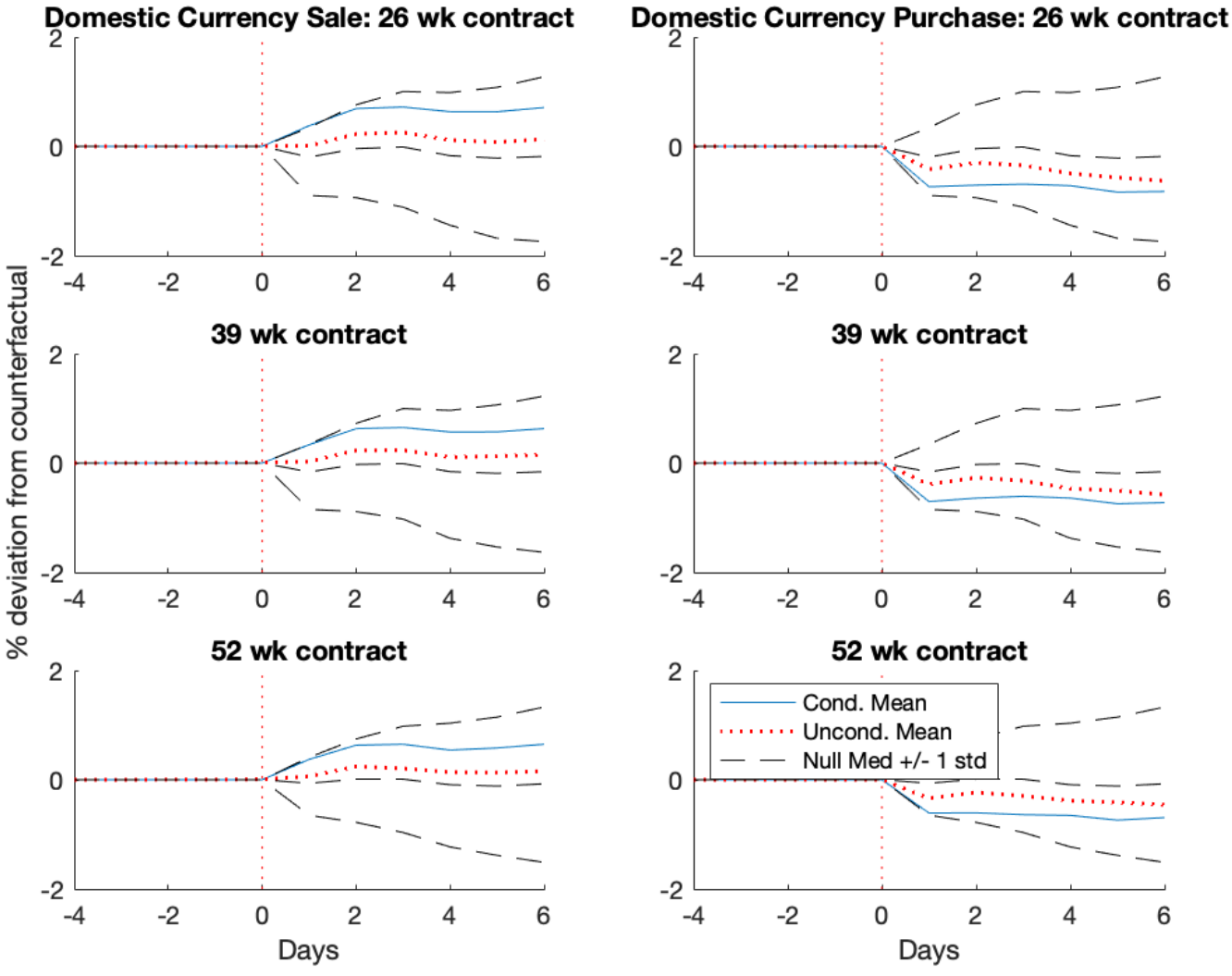
Criteria	Success Rate	p-value	Null
Correct Direction	0.70	0.000	0.50
Correct Direction and 1 std	0.24	0.000	0.16

Conditional Success Rates

Table 5: Conditional Success Rates for Affecting Expectations

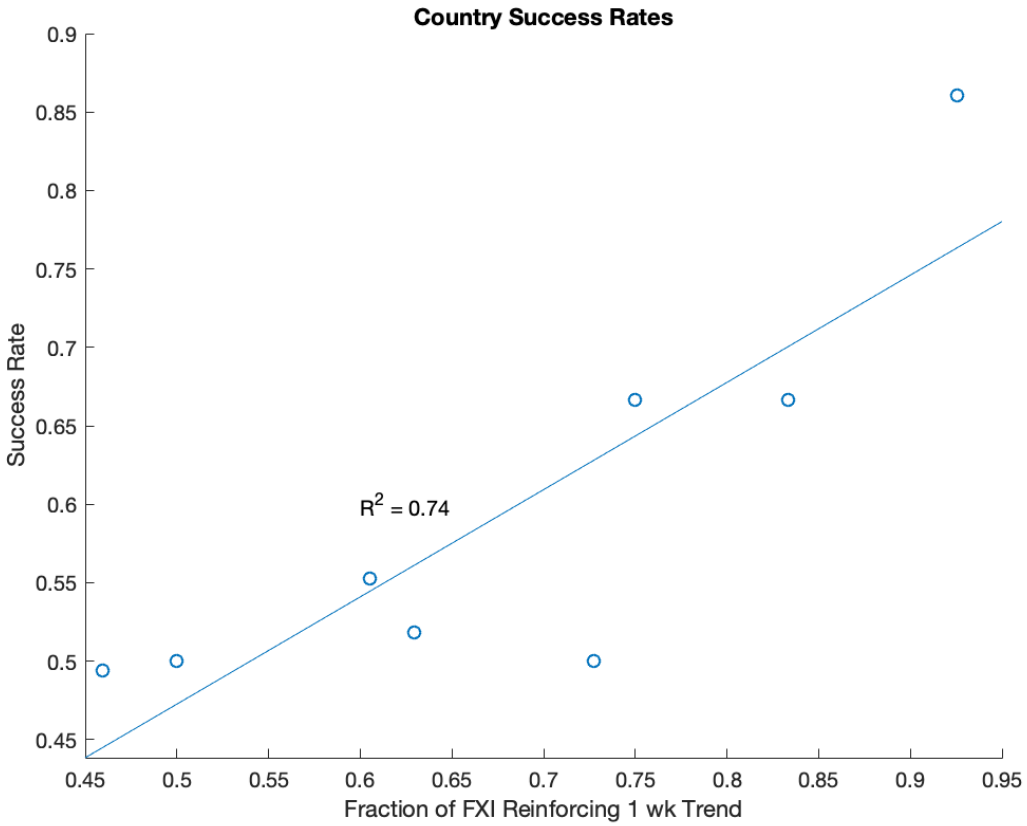
Condition	Conditional Success Rate	p-value
(A) Large Intervention	0.85	0.000
(B) Reinforce 1 week trend	0.82	0.000
(A) and (B)	0.89	0.000
	Conditional Success + 1 std change	**p-value**
(A) Large Intervention	0.26	0.000
(B) Reinforce 1 week trend	0.28	0.000
(A) and (B)	0.27	0.000

Best Case Scenario



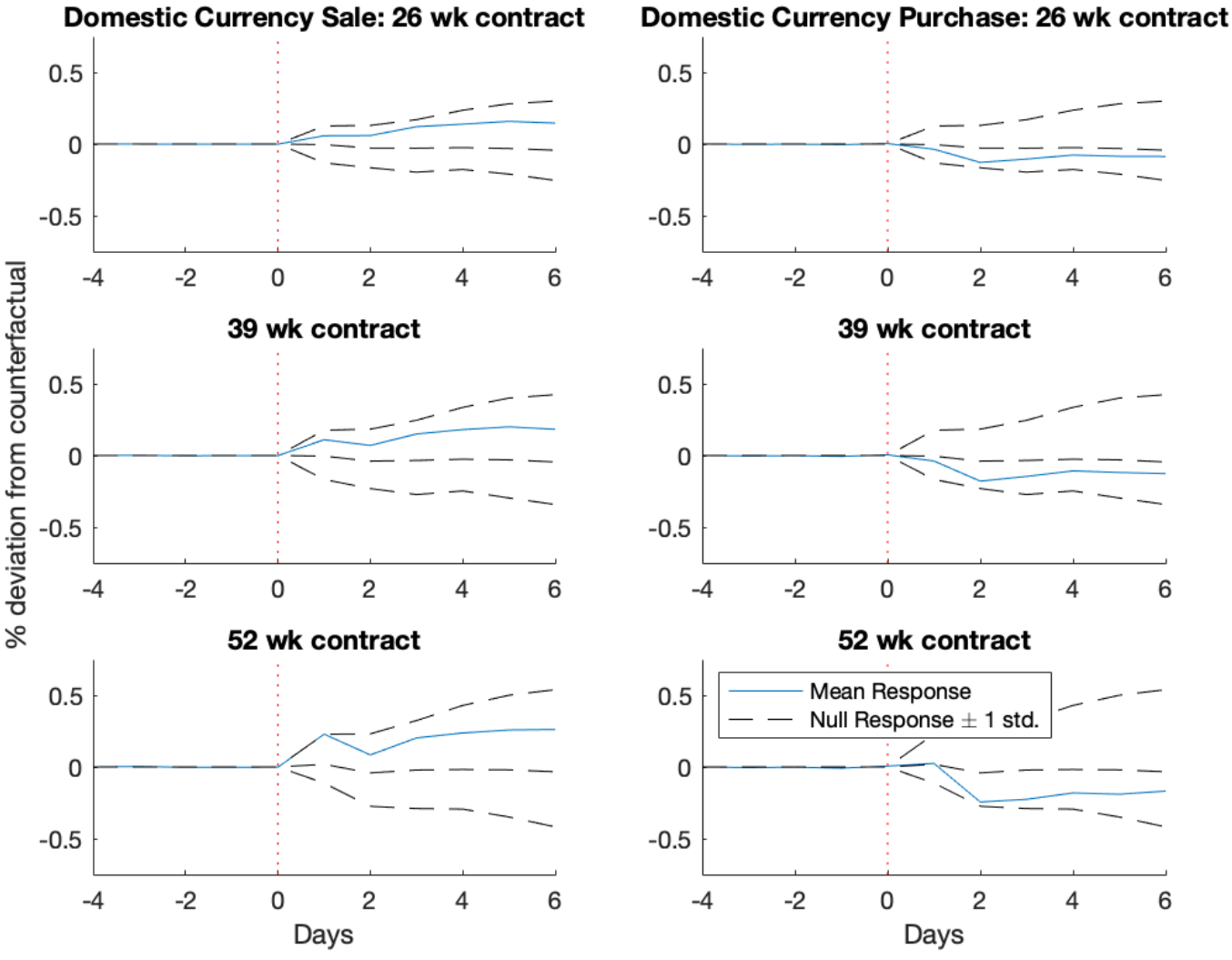
Country Heterogeneity

More successful countries reinforce trend in 1 wk spot price



*Note: 55% of FXI leans against long term trend, but only 25% leans against short term trend

Effect on Risk Premia



Success Rates for Risk Premia

Table 6: Success Rates for Affecting Risk Premia

Criteria	Success Rate	p-value	Null
Correct Direction	0.64	0.000	0.50
Correct Direction and 1 std	0.39	0.000	0.16
1 std (any direction)	0.60	0.000	0.32

Summary & Conclusion

- Strongly reject hypothesis that FXI is ineffective
- FXI induces small permanent change in spot price
- Easy to get correct direction, hard to cause large change
- Most successful when FXI is large and reinforces short-term spot trend
- FXI also increases uncertainty