

The Effect of Capital Controls and Prudential FX Measures on Options-Implied Exchange Rate Stability

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Introduction

- Do capital controls and prudential FX measures help promote exchange rate stability?
- Despite their long (and renewed) popularity, beneficial effects of such policies remain elusive:
 - “capital controls have little power to stop speculative attacks on regimes that were seen by the market as inconsistent” (Dooley, 1996);
 - “empirical analysis has failed to yield conclusive results” (Eichengreen, 2001);
 - do not insulate countries from currency crises. In fact, they increase the likelihood of currency crises (Glick and Hutchison, 2005; and Glick, Guo, and Hutchison, 2006);
 - some effect on the overall volume of capital inflow or on its composition (Bicini, Hutchison, and Schindler, 2010; Qureshi et al, 2011; and Magud et al, 2011).

Introduction

- Why is it so difficult to find a definite answer?
 - Impossibility of controlled experiment (select *ex-ante* identical countries and randomly assign capital controls);
 - Focus on different “outcome” variables (exchange rate, capital flows, inflation, growth, etc...);
 - Divergence with respect to “treatment” variable (how to measure capital controls or financial liberalization).
- Our paper provides new insights on all three issues.

Introduction

- When controlled experiments are not possible:
 - second best: an epidemic affects a large sample simultaneously and different countries adopt “treatment” in different time periods;
 - better than different countries getting sick in different points in time.
- Aftermath of 2008 Global Financial Crisis provides a favorable empirical set up:
 - large-scale asset purchase programs in Federal Reserve, ECB, Bank of England and Bank of Japan is major “push” factor behind capital flows;
 - quantitative easing policies are causing a “monetary tsunami” towards emerging and other developed economies.

Introduction

- Outcome variables:
 - different dimensions of exchange rate stability:
 - probability of frequent and low impact events: volatility;
 - probability of infrequent and high-impact events: tail risk;
 - relative probability of symmetric events: crash risk.
 - Taleb and Blyth (2011): beware of policies which “*push unobserved risks further into the statistical tails of the probability distribution of outcomes and allow these high-impact, low-probability ‘tail risks’ to disappear from policymakers’ field of observation*”.

Introduction

- Measuring treatment variable:
 - policies have been implemented through gradual steps (most *de jure* indices are annual on/off indicators of presence of controls);
 - For instance, in 2010 Turkey increased the required reserve ratio for foreign currency liabilities from 9% to 9.5% on Apr 30, then from 9.5% to 10% on Aug 6, and finally from 10% to 11% on Oct 1st.
 - Using IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER), we compile daily country indices which calculate the cumulative number of relevant policy changes implemented by each individual country over the sample period.

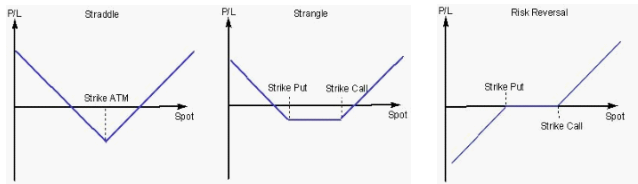
Introduction

- Using a difference-in-differences approach (and with special attention to standard errors), we find evidence that:
 - tightening inflows creates an illusive stability gain: it suppresses daily exchange rate fluctuations, but as a side effect there is an increase in tail risk and no significant gains in terms of crash risk;
 - easing outflows truly improves exchange rate stability across almost all dimensions and all horizons;
 - tightening prudential FX measures which are not specific to derivative markets reduces crash risk and tail risk, with no clear effect on volatility.

Measures of Exchange Rate Stability

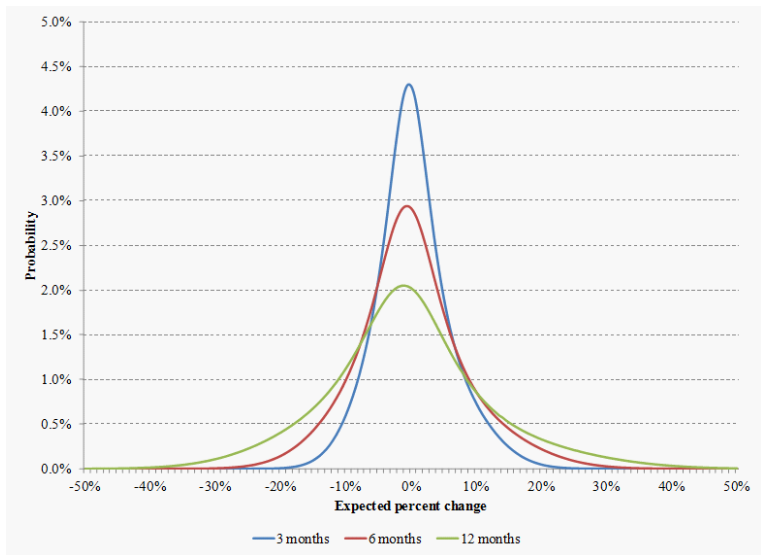
Risk Neutral Probability Density Functions

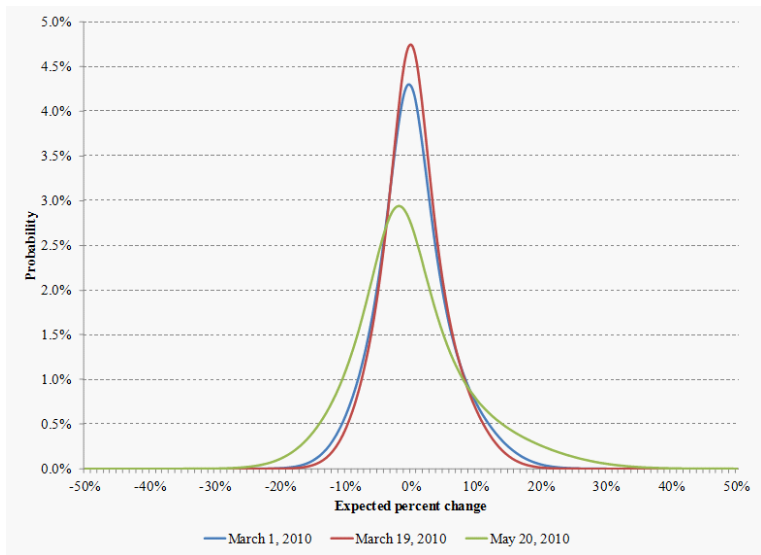
- Malz (1997) shows how to obtain a continuous set of strikes from commonly traded (i.e.: liquid) products:

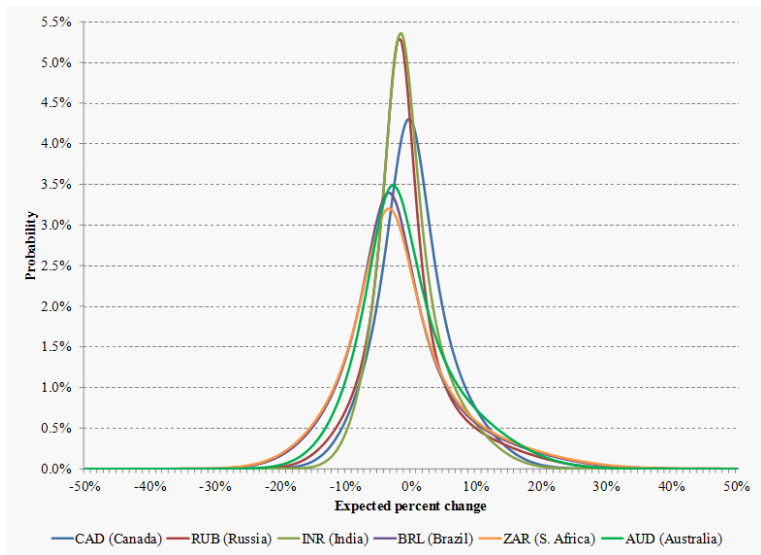


- Breen and Litzenberger (1978) show how to back out risk neutral probability density function (PDF) of expected price movements from a continuous set of derivative prices.

$$C = \int_X^{\infty} e^{-rT} (S_T - X) f(S_T) dS_T$$







Country Name / Currency Code		Obs.	Volatility (Stand. Deviation)				Crash Risk (Skewness)				Tail Risk (Kurtosis)			
			Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.
Australia	AUD	505	16.5%	1.4%	13.2%	21.2%	0.8	0.2	0.4	1.2	4.7	0.4	3.8	5.5
Brazil	BRL	491	17.2%	1.9%	13.9%	20.8%	1.1	0.2	0.8	1.3	5.5	0.4	4.8	6.3
Canada	CAD	505	13.1%	1.9%	9.6%	17.2%	0.3	0.2	-0.1	0.7	4.0	0.2	3.7	4.7
China	CNY	480	4.9%	0.9%	3.6%	7.6%	-0.3	0.5	-1.5	1.2	4.8	0.8	3.5	6.8
Colombia	COP	491	16.9%	2.4%	14.0%	21.2%	0.9	0.2	0.6	1.4	5.6	0.5	4.9	6.9
Czech Republic	CZK	497	15.2%	0.7%	13.1%	17.0%	0.6	0.1	0.3	0.7	4.4	0.2	4.0	4.9
Denmark	DKK	465	14.0%	0.9%	12.2%	16.3%	0.4	0.3	-0.2	0.7	4.1	0.2	3.6	4.8
Hungary	HUF	502	19.3%	1.6%	15.9%	22.4%	0.7	0.1	0.6	0.9	4.7	0.2	4.4	5.2
India	INR	474	11.6%	1.5%	9.2%	15.7%	0.9	0.2	0.5	1.8	5.2	0.6	4.4	8.4
Indonesia	IDR	502	14.7%	2.4%	11.0%	21.3%	1.4	0.2	0.9	1.8	7.3	0.7	5.3	8.8
Israel	ILS	504	9.4%	1.3%	7.6%	13.5%	0.3	0.2	-0.1	0.7	4.7	0.2	4.1	5.4
Malaysia	MYR	492	9.8%	0.9%	8.1%	12.9%	0.9	0.3	0.4	1.4	5.4	0.5	4.6	6.7
Mexico	MXN	500	14.6%	1.5%	12.2%	18.2%	1.0	0.1	0.5	1.3	5.6	0.3	4.7	6.2
New Zealand	NZD	505	17.6%	1.7%	14.6%	22.8%	0.8	0.1	0.5	1.2	4.5	0.3	3.9	5.4
Norway	NOK	495	15.7%	1.1%	13.3%	18.4%	0.3	0.2	0.0	0.6	3.9	0.1	3.6	4.5
Philippines	PHP	499	11.0%	1.3%	9.0%	14.4%	1.0	0.2	0.6	1.6	5.7	0.7	4.7	8.1
Poland	PLN	500	18.9%	1.3%	16.3%	22.0%	0.7	0.1	0.4	0.8	4.7	0.2	4.2	5.3
Russia	RUB	499	14.9%	2.8%	11.3%	21.9%	1.1	0.2	0.4	1.4	6.2	0.6	5.1	7.3
Singapore	SGD	504	8.0%	0.7%	6.1%	10.2%	0.7	0.3	0.1	1.2	4.9	0.3	4.2	6.2
South Africa	ZAR	505	17.8%	2.0%	15.5%	21.9%	0.9	0.1	0.5	1.1	5.2	0.2	4.6	5.7
South Korea	KRW	504	15.0%	1.4%	11.7%	21.4%	1.1	0.2	0.6	1.7	5.9	0.5	4.8	7.5
Sweden	SEK	501	15.9%	1.3%	13.4%	18.9%	0.4	0.2	0.0	0.6	3.9	0.2	3.1	4.5
Switzerland	CHF	505	12.8%	0.8%	10.9%	15.1%	-0.1	0.2	-0.4	0.4	3.9	0.1	3.6	4.4
Thailand	THB	496	8.0%	1.3%	5.7%	12.7%	0.5	0.3	0.0	1.3	4.3	0.5	3.4	6.7
Turkey	TRY	504	15.2%	1.3%	13.2%	18.7%	1.0	0.1	0.7	1.3	5.5	0.4	4.5	6.5
All countries		13,940	14.0%	3.7%	3.6%	22.8%	0.6	0.5	-1.5	1.8	4.9	0.9	3.1	8.8

Capital Controls and Prudential FX Measures

- Using IMF's AREAER to compile two indices of policy changes in *de jure* capital controls and prudential FX measures for each individual country in our sample.
- Motivation: gauge the effectiveness of policies aimed at curbing potentially destabilizing effects of large portfolio inflows.

Capital Controls and Prudential FX Measures

Capital Controls

- First, only include policy changes aimed at easing or tightening restrictions on cross-border financial transactions typically associated to speculative “hot money”:
 - Fixed-income securities;
 - Portfolio equity shares.
- Second, disregard policy changes which only affect the reinvestment of dividends or earnings.
- Third, distinguish among policies:
 - explicitly imposed to affect the absolute size of transactions (quantity-based), the timing of transactions (time-based), or the return of transactions (price-based);
 - restrictions on non-residents (inflows) from residents (outflows).

Capital Controls and Prudential FX Measures

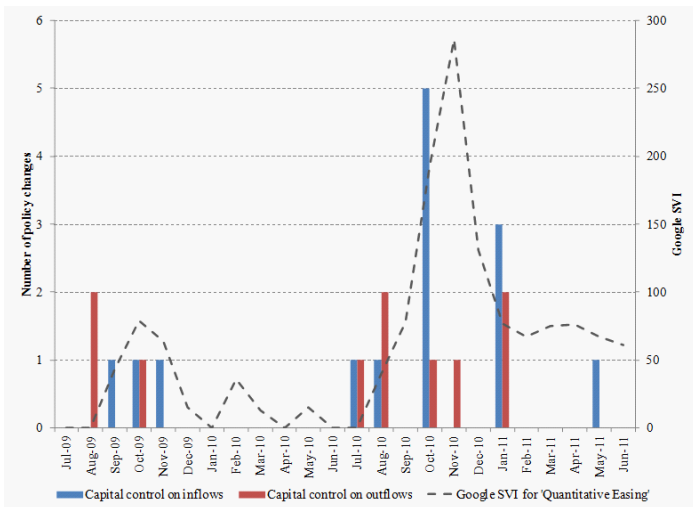
Prudential FX Measures

- Prudential FX measures encompass policy changes which are not aimed at controlling capital flows *per se*, but at controlling the exchange rate risk on financial institutions' balance sheets arising from such capital flows.
- Typical prudential FX measures also tend to differ operationally from capital controls as they restrict holdings of foreign assets or liabilities by imposing limits not to the absolute size of portfolios, but to their relative composition instead.
- Differentiate between prudential FX measures which apply exclusively to FX derivatives from other FX assets and liabilities.

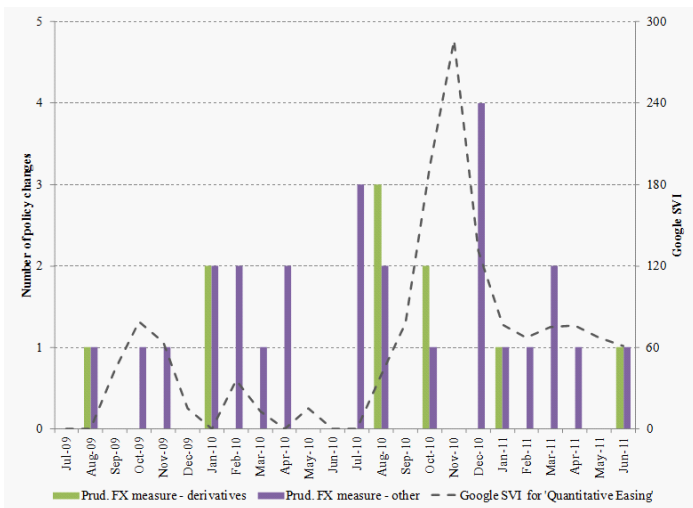
Capital Controls and Prudential FX Measures

	<i>Capital Controls</i>								<i>Prudential FX Measures</i>				<i>Total</i>			
	Quantity-based				Time-based				Price-based					FX derivatives	Other FX assets and liabilities	
	Inflow		Outflow		Inflow		Outflow		Inflow		Outflow				+	-
+	-	+	-	+	-	+	-	+	-	+	-	+	-			
<i>Brazil</i>								9	1			1		1		12
<i>China</i>		2														2
<i>Colombia</i>			1	2								2				5
<i>India</i>														4	1	5
<i>Indonesia</i>					2									3	1	6
<i>Israel</i>												1				1
<i>Philippines</i>				1												1
<i>Russia</i>														4	1	5
<i>South Africa</i>				3											4	7
<i>South Korea</i>												4		4		8
<i>Thailand</i>				3									2			5
<i>Turkey</i>														3		3
<i>Total</i>		2	1	9	2			9	1			8	2	19	7	60

Capital Controls and Prudential FX Measures



Capital Controls and Prudential FX Measures



Capital Controls and Prudential FX Measures

Indices

- The capital control index, CCI_{it} , and prudential FX measure index, PMI_{it}^{FX} calculate the cumulative number of relevant policy changes implemented by each individual country over the sample period:
 - Each country is assigned a value of zero in the first day of our sample period, Jul 1st, 2009;
 - Changes which tighten capital controls or prudential regulations add a value of one to the respective cumulative index on the day they become effective;
 - Changes which ease capital controls or prudential regulations subtract a value of one.
- Problem: are we comparing different things (time-series gain versus cross-country losses)?

Empirical Evidence

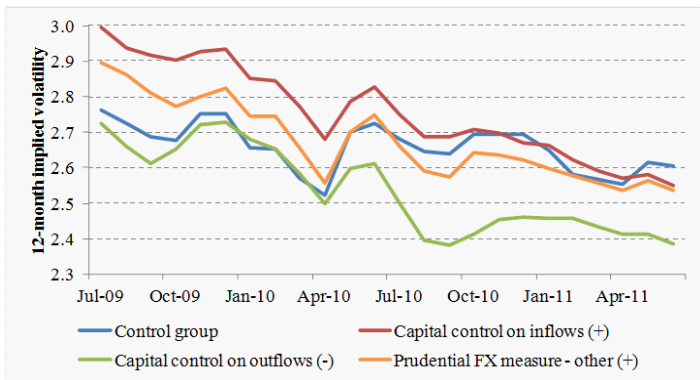
Empirical Strategy

$$\begin{aligned}
 \text{volatility}_{it}^{\tau} &= \vec{\beta}_1^{\tau} CCI_{it} + \vec{\beta}_2^{\tau} PMI_{it}^{FX} + \vec{\beta}_3^{\tau} T_t + \vec{\beta}_4^{\tau} C_i + \varepsilon_{it}^{\tau} \\
 \text{abs}(\text{crash risk}_{it}^{\tau}) &= \vec{\gamma}_1^{\tau} CCI_{it} + \vec{\gamma}_2^{\tau} PMI_{it}^{FX} + \vec{\gamma}_3^{\tau} T_t + \vec{\gamma}_4^{\tau} C_i + v_{it}^{\tau} \\
 \text{tail risk}_{it}^{\tau} &= \vec{\delta}_1^{\tau} CCI_{it} + \vec{\delta}_2^{\tau} PMI_{it}^{FX} + \vec{\delta}_3^{\tau} T_t + \vec{\delta}_4^{\tau} C_i + v_{it}^{\tau}
 \end{aligned}$$

- Difference-in-differences estimator:
 - daily panel of 25 countries/currencies from July 1st, 2009 until June 30, 2011;
 - $\tau = 3, 6$, and 12 months;
 - standard errors clustered by country and date (clustering in two dimensions is particularly important to avoid “over-rejection” of the null).

Empirical Evidence

Empirical Strategy



Empirical Evidence

Baseline Regression

Dependent variable:	3-month maturity			6-month maturity			12-month maturity		
	<i>Volatility</i>	<i>Crash Risk</i>	<i>Tail Risk</i>	<i>Volatility</i>	<i>Crash Risk</i>	<i>Tail Risk</i>	<i>Volatility</i>	<i>Crash Risk</i>	<i>Tail Risk</i>
<i>Capital Controls - Price-based (inflow)</i>	-0.025*** (0.005)	-0.038* (0.022)	0.015*** (0.002)	-0.021*** (0.004)	-0.026 (0.019)	0.020*** (0.002)	-0.016*** (0.004)	-0.017 (0.019)	0.018*** (0.002)
<i>Capital Controls - Quantity-based (inflow)</i>	-0.313*** (0.016)	0.360*** (0.091)	0.431*** (0.011)	-0.139*** (0.015)	0.077 (0.090)	0.302*** (0.012)	0.085*** (0.014)	-0.069 (0.098)	0.174*** (0.012)
<i>Capital Controls - Time-based (inflow)</i>	-0.238*** (0.017)	0.096 (0.079)	0.113*** (0.011)	-0.176*** (0.015)	0.062 (0.077)	0.123*** (0.012)	-0.145*** (0.015)	-0.050 (0.074)	0.090*** (0.012)
<i>Capital Controls - Quantity-based (outflow)</i>	0.037 (0.023)	0.811*** (0.297)	0.067*** (0.016)	0.044** (0.020)	0.775*** (0.262)	0.071*** (0.014)	0.061*** (0.018)	0.543*** (0.118)	0.072*** (0.013)
<i>Prudential FX Measures - FX Derivatives</i>	-0.021 (0.029)	0.312** (0.139)	0.030*** (0.009)	-0.008 (0.026)	0.246** (0.115)	0.025*** (0.008)	0.008 (0.022)	0.100* (0.056)	0.018*** (0.006)
<i>Prudential FX Measures - Other FX Assets and Liabilities</i>	0.006 (0.012)	-0.217*** (0.076)	-0.021*** (0.006)	0.000 (0.011)	-0.217*** (0.067)	-0.026*** (0.006)	-0.009 (0.009)	-0.177*** (0.042)	-0.032*** (0.007)
Number of observations:	12,409	12,409	12,409	12,423	12,423	12,423	12,425	12,425	12,425
R^2	94.6%	60.2%	81.9%	95.8%	60.5%	84.2%	95.8%	64.1%	86.4%

Empirical Evidence

Robustness Checks

- Our results are robust to:
 - Disaggregation at country level: “average” effect is not dominated by one successful country experience;
 - Different country samples: non-Europeans or emerging markets only;
 - Collapsing at quarterly frequency.

Empirical Evidence

Disaggregation at Country Level (1/3)

Dependent variable:	3-month maturity			6-month maturity			12-month maturity		
	Volatility	Crash Risk	Tail Risk	Volatility	Crash Risk	Tail Risk	Volatility	Crash Risk	Tail Risk
<i>Capital Controls - Price-Based - Brazil (inflow)</i>	-0.036*** (0.008)	-0.162** (0.067)	0.008 (0.006)	-0.029*** (0.006)	-0.113* (0.065)	0.021*** (0.006)	-0.018*** (0.006)	-0.128* (0.071)	0.014** (0.007)
<i>Capital Controls - Quantity-based - China (inflow)</i>	-0.314*** (0.018)	0.356*** (0.098)	0.433*** (0.011)	-0.139*** (0.016)	0.075 (0.095)	0.305*** (0.012)	0.086*** (0.015)	-0.063 (0.101)	0.177*** (0.013)
<i>Capital Controls - Time-based - Indonesia (inflow)</i>	-0.240*** (0.019)	0.070 (0.089)	0.109*** (0.012)	-0.179*** (0.017)	0.030 (0.090)	0.115*** (0.013)	-0.150*** (0.017)	-0.095 (0.087)	0.078*** (0.013)
<i>Capital Controls - Quantity-based - Colombia (outflow)</i>	-0.176*** (0.022)	0.120 (0.134)	0.104*** (0.015)	-0.144*** (0.020)	0.132 (0.176)	0.085*** (0.012)	-0.110*** (0.020)	-0.034 (0.137)	0.121*** (0.012)
<i>Capital Controls - Quantity-based - Philippines (outflow)</i>	0.038 (0.024)	0.307*** (0.098)	0.169*** (0.015)	0.039* (0.021)	0.305*** (0.090)	0.151*** (0.017)	0.044** (0.018)	0.336*** (0.088)	0.127*** (0.017)
<i>Capital Controls - Quantity-based - South Africa (outflow)</i>	0.004 (0.010)	0.301*** (0.085)	0.038*** (0.009)	0.015* (0.008)	0.284*** (0.081)	0.023*** (0.009)	0.024*** (0.008)	0.253*** (0.088)	0.010 (0.008)
<i>Capital Controls - Quantity-based - Thailand (outflow)</i>	0.031* (0.016)	1.709*** (0.055)	0.041*** (0.009)	0.025** (0.011)	1.664*** (0.048)	0.084*** (0.010)	0.064*** (0.010)	0.716*** (0.041)	0.077*** (0.010)
Number of observations:	12,409	12,409	12,409	12,423	12,423	12,423	12,425	12,425	12,425
R^2	95.0%	63.4%	82.5%	96.1%	63.1%	84.7%	96.1%	64.8%	86.8%

Empirical Evidence

Disaggregation at Country Level (2/3)

Dependent variable:	3-month maturity			6-month maturity			12-month maturity		
	Volatility	Crash Risk	Tail Risk	Volatility	Crash Risk	Tail Risk	Volatility	Crash Risk	Tail Risk
<i>Prudential FX Measures - FX</i>	0.029	1.136***	0.083**	0.033	0.794**	0.009	0.023	0.777**	0.021
<i>Derivatives - Brazil</i>	(0.031)	(0.341)	(0.035)	(0.027)	(0.319)	(0.032)	(0.026)	(0.352)	(0.031)
<i>Prudential FX Measures - FX</i>	-0.196***	-0.165	0.031**	-0.164***	-0.154	0.023*	-0.133***	-0.246**	0.047***
<i>Derivatives - Colombia</i>	(0.021)	(0.114)	(0.014)	(0.019)	(0.130)	(0.013)	(0.019)	(0.113)	(0.014)
<i>Prudential FX Measures - FX</i>	0.150***	0.595***	-0.001	0.1***	0.483***	-0.002	0.062***	0.451***	0.012
<i>Derivatives - Israel</i>	(0.024)	(0.099)	(0.015)	(0.021)	(0.090)	(0.016)	(0.018)	(0.088)	(0.017)
<i>Prudential FX Measures - FX</i>	-0.047***	0.019	0.029***	-0.028**	-0.059	0.026***	-0.015	-0.086**	0.009
<i>Derivatives - South Korea</i>	(0.012)	(0.035)	(0.007)	(0.011)	(0.045)	(0.008)	(0.010)	(0.042)	(0.008)
<i>Prudential FX Measures - FX</i>	-0.045**	0.062	0.054***	-0.017	-0.143	-0.012	-0.012	0.109	-0.002
<i>Derivatives - Thailand</i>	(0.022)	(0.121)	(0.013)	(0.014)	(0.123)	(0.015)	(0.013)	(0.127)	(0.013)
Number of observations:	12,409	12,409	12,409	12,423	12,423	12,423	12,425	12,425	12,425
R^2	95.0%	63.4%	82.5%	96.1%	63.1%	84.7%	96.1%	64.8%	86.8%

Empirical Evidence

Disaggregation at Country Level (3/3)

Dependent variable:	3-month maturity			6-month maturity			12-month maturity		
	Volatility	Crash Risk	Tail Risk	Volatility	Crash Risk	Tail Risk	Volatility	Crash Risk	Tail Risk
<i>PFXM - Other FX Assets and Liabilities - Brazil</i>	0.069*** (0.021)	-0.182** (0.087)	-0.052*** (0.008)	0.029* (0.017)	-0.133 (0.089)	-0.016 (0.010)	-0.020 (0.015)	-0.025 (0.059)	0.013 (0.010)
<i>PFXM - Other FX Assets and Liabilities - India</i>	-0.020** (0.008)	-0.088** (0.043)	-0.008 (0.005)	-0.025*** (0.007)	-0.101** (0.046)	-0.019*** (0.006)	-0.026*** (0.007)	-0.148*** (0.048)	-0.034*** (0.006)
<i>PFXM - Other FX Assets and Liabilities - Indonesia</i>	0.023** (0.010)	-0.065** (0.026)	-0.015*** (0.004)	0.012 (0.009)	-0.055** (0.027)	-0.004 (0.006)	0.005 (0.008)	0.003 (0.023)	0.011* (0.006)
<i>PFXM - Other FX Assets and Liabilities - Russia</i>	-0.049*** (0.012)	-0.241*** (0.046)	-0.06*** (0.006)	-0.06*** (0.009)	-0.264*** (0.043)	-0.065*** (0.007)	-0.068*** (0.008)	-0.266*** (0.047)	-0.055*** (0.007)
<i>PFXM - Other FX Assets and Liabilities - South Africa</i>	0.014** (0.006)	-0.084** (0.035)	-0.013* (0.007)	0.011** (0.005)	-0.057* (0.033)	0.000 (0.005)	0.008 (0.005)	-0.013 (0.032)	0.010** (0.004)
<i>PFXM - Other FX Assets and Liabilities - South Korea</i>	0.047*** (0.009)	-0.035 (0.030)	-0.013*** (0.004)	0.037*** (0.009)	-0.029 (0.042)	-0.020*** (0.005)	0.029*** (0.009)	-0.071* (0.036)	-0.025*** (0.006)
<i>PFXM - Other FX Assets and Liabilities - Turkey</i>	0.022** (0.009)	-0.144*** (0.045)	-0.029*** (0.006)	0.01 (0.008)	-0.177*** (0.044)	-0.041*** (0.006)	-0.008 (0.008)	-0.208*** (0.042)	-0.049*** (0.006)
Number of observations:	12,409	12,409	12,409	12,423	12,423	12,423	12,425	12,425	12,425
R ²	95.0%	63.4%	82.5%	96.1%	63.1%	84.7%	96.1%	64.8%	86.8%

Conclusion

- Has the recent wave of capital controls and prudential FX measures helped promote exchange rate stability?
 - tightening inflows creates an illusive stability gain: it suppresses daily exchange rate fluctuations, but as a side effect there is an increase in tail risk and no significant gains in terms of crash risk;
 - easing outflows truly improves exchange rate stability across all dimensions and most all horizons;
 - tightening prudential FX measures which are not specific to derivative markets reduces crash risk and tail risk, with no clear effect on volatility.

Conclusion

Thank you!