

FX interventions in Brazil: a synthetic control approach¹

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Introduction

- ▶ The extraordinary monetary policies pursued in developed countries (and the eventual normalization of those policies) created many problems for central banks in developing countries trying to manage their economies.
- ▶ Expressions like "currency wars" or "monetary tsunamies" marked the monetary expansion phase.
- ▶ Many (IT) central banks complained:
 - ▶ *According to the Central Bank of Brazil: "... the fragility in some mature economies, combined with favorable perspectives for the Brazilian economy has determined an inflow of foreign resources, part of which has been going to the credit market. In this sense, the excess of external inflows may weak (sic) the credit channel, smooth its contribution to the aggregate demand moderation as well as cause distortions in the price of domestic assets" (Central Bank of Brazil, 2011).*
 - ▶ *The Central Bank of Chile warned: "... the main risks for financial stability associated with larger gross capital inflows include the generation of currency and maturity mismatches, credit booms that lead to a deterioration in loan quality, and local asset price misalignment" (Central Bank of Chile, 2011).*

Introduction

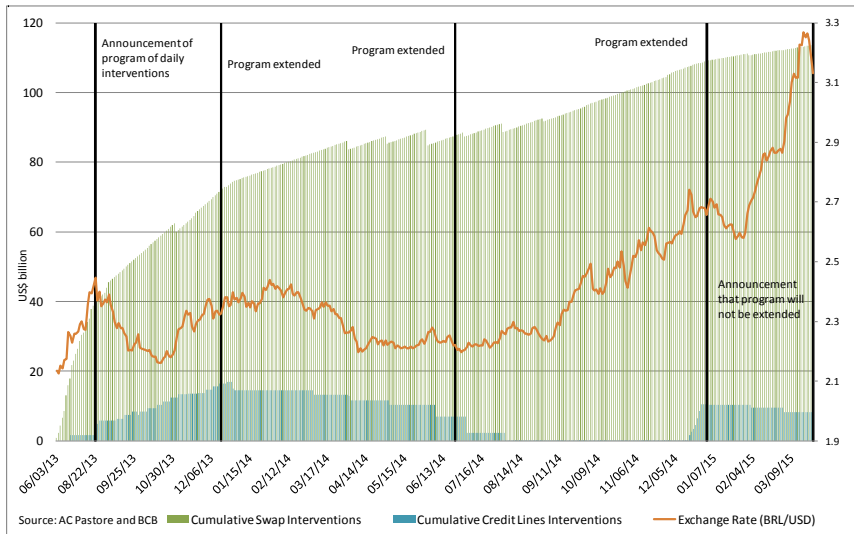
- ▶ *The Central Bank of Turkey admonished: "... in emerging economies, short-term capital flows and rapid credit growth feed macro financial risks. [...] The major risk factor for emerging economies is the macroeconomic imbalances driven by rapid capital inflows. Central banks of emerging economies continued to implement macroprudential measures to contain the potential adverse effects of capital flows" (Central Bank of Turkey, 2011).*
- ▶ But the policy normalization phase wasn't any better.
- ▶ The "taper tantrum" created havoc in risky assets, especially EM currencies.
- ▶ This paper deals with the impacts of and policy reactions to the taper tantrum in Brazil.

Introduction

- ▶ Are sterilized interventions effective? Do they change the level and/or the volatility of the ER?
- ▶ Endogeneity problems: countries intervene only when there are large and undesirable movements of the ER
 - ▶ the endogeneity bias may understate the effect of the interventions.
- ▶ VARs, IVs and high-frequency data are often used, but may not well address the endogeneity problems.
- ▶ We use a large, “pre-announced”, FX intervention program deployed by the Brazilian Central Bank in the wake of the Taper Tantrum.
- ▶ Because the program came as a surprise, it is ideal to apply techniques of synthetic control; we use techniques by Abadie et al. (2010), Carvalho et al. (2016) and event study for robustness check.
- ▶ We find a large effect of the program announcement on the level of the exchange rate (at least 10% appreciation), but not as much effect on the ER volatility; extensions of the original program were not as effective.

FX Intervention Program in Brazil

- ▶ On August 22, 2013 the central bank announced a major program of FX intervention:
 - ▶ Daily sales of US\$ 500 million worth of currency forwards.
 - ▶ US\$ 1 billion spot every Friday through repurchase agreements.
 - ▶ Program to last until at least the end of the year.
- ▶ On December 18, 2013 program extended:
 - ▶ Daily sales reduced to US\$ 200 million.
 - ▶ Spot interventions if liquidity needed.
 - ▶ Program to last until at least mid-2014.
- ▶ On June 2014 program extended to end-2014.
- ▶ On December 2014, the program was extended and it ended on March 31, 2015.



Equivalence between FX Forward Interventions and Sterilized Interventions

- ▶ Here, the exchange rate is quoted in units of BRL per USD.
- ▶ The BCB commits to sell $(1+i^*)$ USD at $t+1$ for $(1+i^*) \cdot F$ BRL;
- ▶ The private sector portfolio, **in t**
 - ▶ **Increases** by the present value of $(1+i^*)$ USD in $t+1$, i.e., **1 USD**;
 - ▶ **Decreases** by the present value of $(1+i^*) \cdot F$, i.e., $(1+i^*) \cdot F / (1+i) = \mathbf{S \text{ BRL}}$ (by CIP).
- ▶ This FX forward intervention has the same effects of a sterilized sale of USD by the BCB, i.e.
 - ▶ The BCB sells **1 USD**, and conducts open market purchases in the same amount, i.e., **S BRL**.
- ▶ The CIP basis exists, but is of 2nd order for the purposes of this paper (*cupom cambial* is the onshore dollar rate, usually higher than *libor*).

FX Intervention Program in Brazil

- ▶ Program was large:
 - ▶ Announcement implied ~ USD \$50 billion
 - ▶ Eventual stock reached ~ USD \$110 billion. This is about 1/3 of the stock of reserves
- ▶ FX Interventions through currency forward:
 - ▶ Settle in BRL

Literature on Intervention

- ▶ Not much theoretical literature supporting effectiveness:
 - ▶ Portfolio balance effect;
 - ▶ Signaling effect.
- ▶ There is a very large empirical literature on FX Intervention.
 - ▶ Sarno and Taylor (2001) survey early literature (mainly advanced economies); evidence not supportive (intervention tiny compared to size of bond markets).
 - ▶ Menkhoff (2013) provides a more recent survey covering Emerging Markets, where evidence is more supportive (intervention can be sizable relative to domestic bond markets).

The Effectiveness of Sterilized Interventions

- ▶ “In any event, governments plainly believe that sterilized intervention has its uses, for they continue to practice it despite the lack of any hard evidence that it is consistently and predictably effective.” (OR, 1996)
- ▶ “Despite many empirical studies, it is not clear yet whether sterilized intervention meets the same criteria that regulators use to decide whether to approve a cancer drug - that it is safe and effective.” (Engel, 2015)

Literature on Intervention

- ▶ In the Brazilian context, a number of papers of intervention, including:
 - ▶ Andrade and Kohlscheen (2014) estimates a 0.3% movement after announcement of a swap auction
 - ▶ Barroso (2014) estimates a 0.5% effect for a US\$ 1 billion intervention.
 - ▶ Vervloet (2010) estimates effect of US\$ 1 billion intervention to be 0.10-1.14% (with low duration)
 - ▶ Broadly speaking, estimates in the range of 0.1-0.5 percent for a US\$ 1 billion intervention.

Our paper

- ▶ To find an instrument for daily FX sterilized interventions is hard;
- ▶ The Brazilian program was different because all the news about future FX interventions was concentrated at the announcement;
- ▶ This begs a methodology like diff-in-diff, and synthetic controls is the way to implement it.
- ▶ Our paper is the first to apply these methodologies to FX sterilized interventions.
- ▶ The quite sizeable result (10% appreciation of the exchange rate) is large compared to the literature.

Estimating the Effect

- ▶ We use a synthetic control approach (Abadie et al. 2010) and an alternative new econometric methodology that estimates a synthetic control using the time-series dimension of the data (ArCo, Carvalho et al. 2016) to estimate the effect of the program on the exchange rate and its volatility;
 - ▶ In a nutshell it consists of using data from other countries to construct a synthetic Brazil, i.e, a counterfactual.
- ▶ Synthetic control not suitable for studying small frequent interventions, but suitable for large event;
- ▶ Results also complemented with a standard event-study regression.

Synthetic Controls

- ▶ We estimate weights for different countries that can explain the behavior of the exchange rate in Brazil prior to the program announcement, following Abadie et al.(2010).
- ▶ Log change in the counterfactual exchange rate will be given by weighted average of the log change in the exchange rate for the other countries.
- ▶ Weights minimize the mean square error (in the pre-program period) of the log change in the exchange rate and other control variables.

Abadie et al. (2010)

- ▶ Let Y_{it}^I denote the exchange rate in a country i in period t for a country that adopts a policy (e.g. an FX intervention program) at time T_0 , and Y_{it}^N denote non-observed exchange rate that would have occurred had the country not adopted the FX interventions program.
- ▶ Without loss of generality, suppose the policy change occurred on country $i = 1$ (Brazil in our case). We assume that Y_{it}^N follows a factor model given by:

$$Y_{it}^N = \delta_t + \theta_t Z_i + \lambda_t \mu_i + \varepsilon_{it}$$

where λ_t is an unknown common factor that depends on time, Z_i is a vector of observable variables, θ_t is a vector of parameters and μ_i is a unobserved vector of factor loadings. At last, ε_{it} is a mean zero iid shock.

Abadie et al. (2010)

- ▶ Consider $W = (\omega_2, \dots, \omega_{j+1})'$ as a vector of weights such that $\omega_i \geq 0$ and $\sum_{i=2}^{j+1} \omega_i = 1$. Suppose that there is an optimal weight vector \hat{W} that can accurately replicate pre-treatment observations in Brazil. Abadie et al. (2010) show that under regular conditions $Y_{it}^N = \sum_{i=2}^{j+1} \hat{\omega}_i Y_{it}$. Thus, we can calculate $\hat{\alpha}_{1t} = Y_{it} - \sum_{i=2}^{j+1} \hat{\omega}_i Y_{it}$ for $t \geq T_0$.
- ▶ Define X_1 as a matrix of pre-treatment characteristics of the Brazilian exchange rate that contains Y and Z , and similarly X_0 for the control countries. Hence, the optimal weight vector \hat{W} is chosen through the minimization of the following equation

$$\sqrt{(X_1 - X_0 \hat{W})' V (X_1 - X_0 \hat{W})} \quad (1)$$

where V is a $k \times k$ symmetric and positive semi-definite matrix (k is the number of explanatory variables). Also V is chosen to minimize the mean square prediction error in the period prior to the policy change.

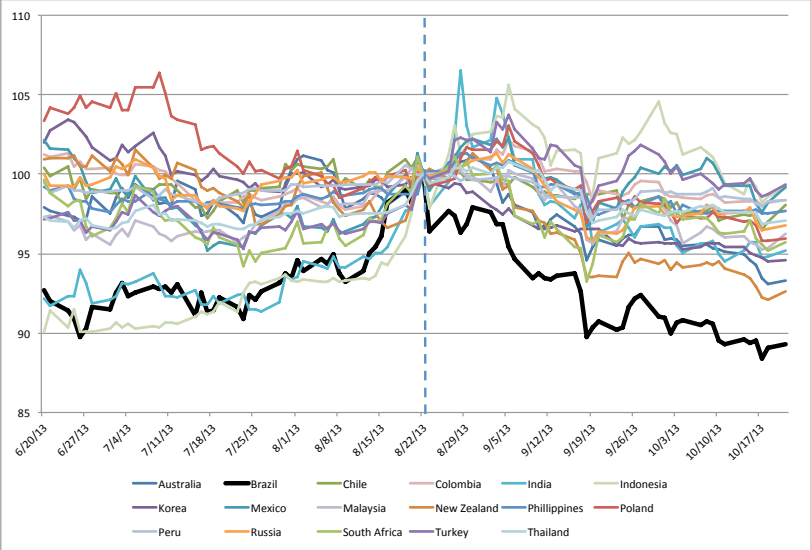
ArCo - Carvalho et al. (2016)

- ▶ We also an alternative new econometric methodology that estimates a synthetic control using the time-series dimension of the data proposed by Carvalho et al. (2016), which allows for negative weights and statistical inference.
- ▶ Abadie et al. (2010) kills the time-series dimension by using time averages of variables;
- ▶ ArCo incorporates the time-series dimension;
- ▶ Basically, the counterfactual is constructed by regressing the variable of interest for the treated country in the control variables for the donor pool (other countries).

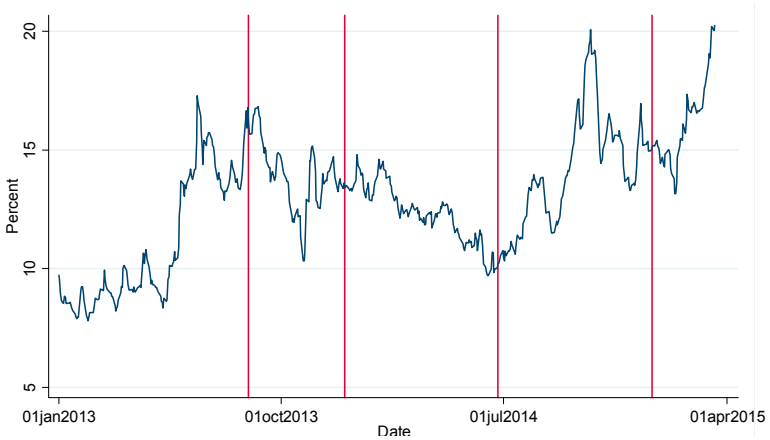
Data

- ▶ We use weekly data for:
 - ▶ Log Change in the Exchange Rate
 - ▶ Log Change in the Volatility
 - ▶ Log Change in Equity Index
 - ▶ Log Change in Bond Index
 - ▶ Portfolio Flows (EPFR) scaled by 2012 GDP
- ▶ Our sample consists of 16 countries: Australia, Brazil, Chile, Colombia, India, Indonesia, Korea, Malaysia, Mexico, New Zealand, Peru, Philippines, Poland, Russia, South Africa, Thailand, and Turkey.

BRL vs. Peers After The Program Announcement



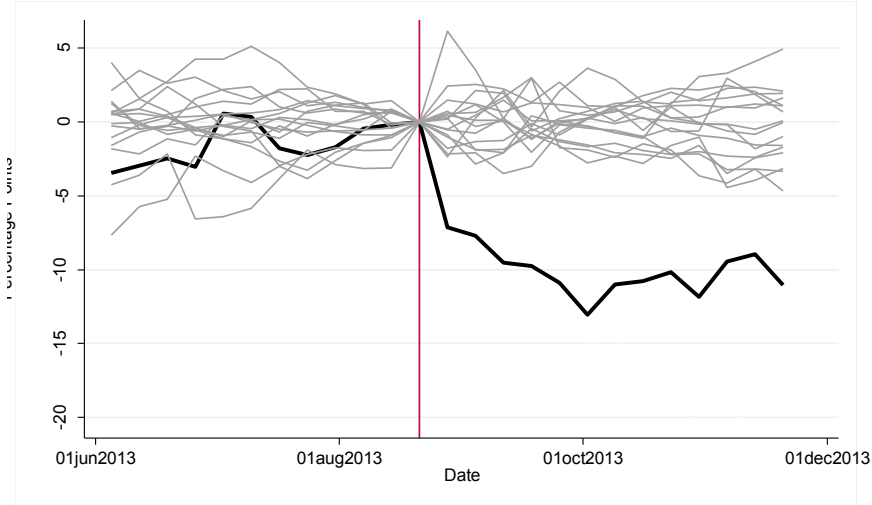
Brazilian Real Option-Implied Volatility



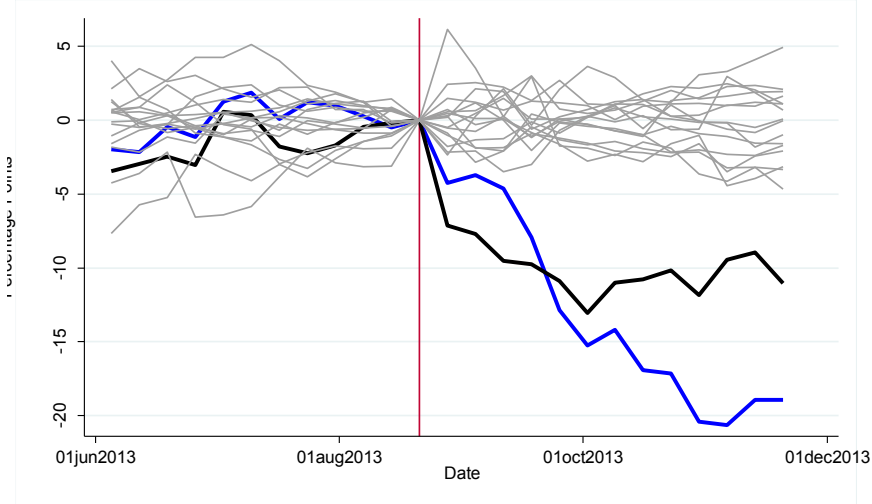
Brazilian Real Option-Implied Risk Reversal



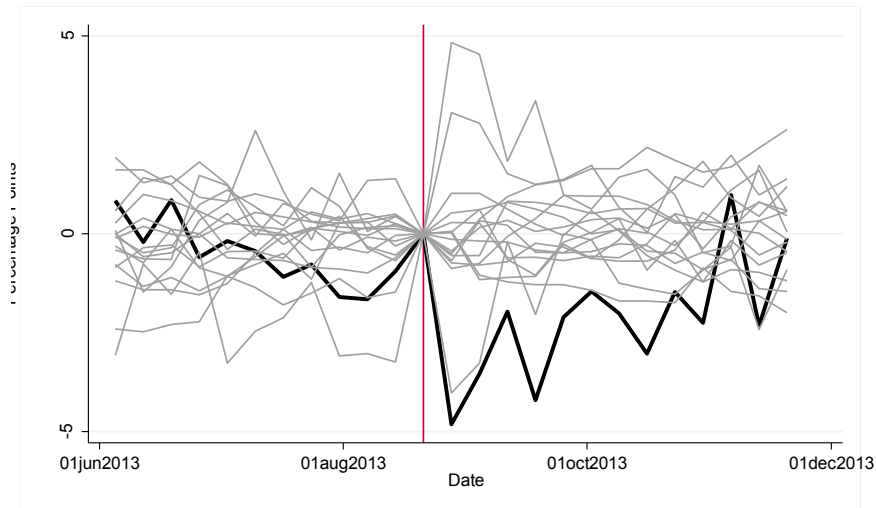
Effect of Program Announcement on the Exchange Rate



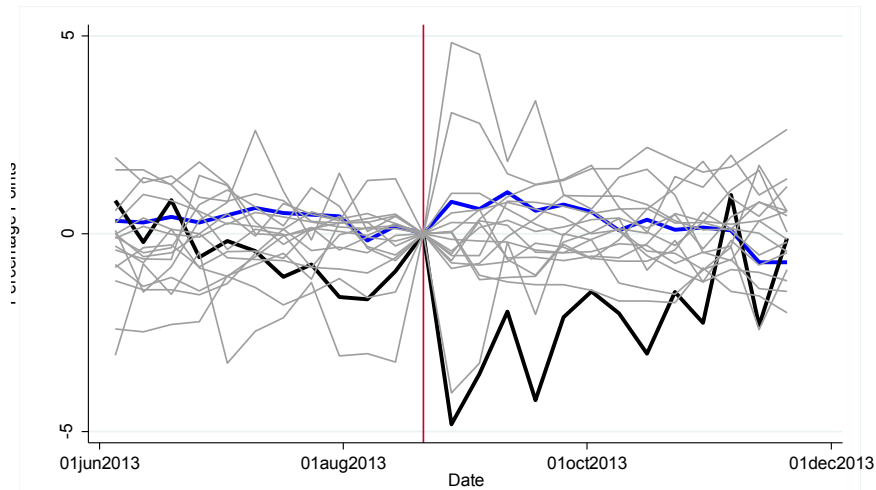
Effect of Program Announcement on the Exchange Rate



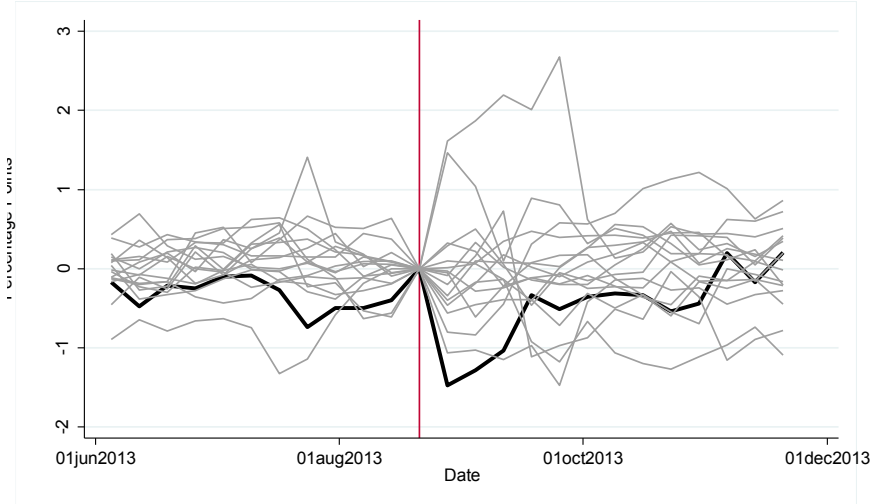
Effect of Program Announcement on Option-Implied Volatility



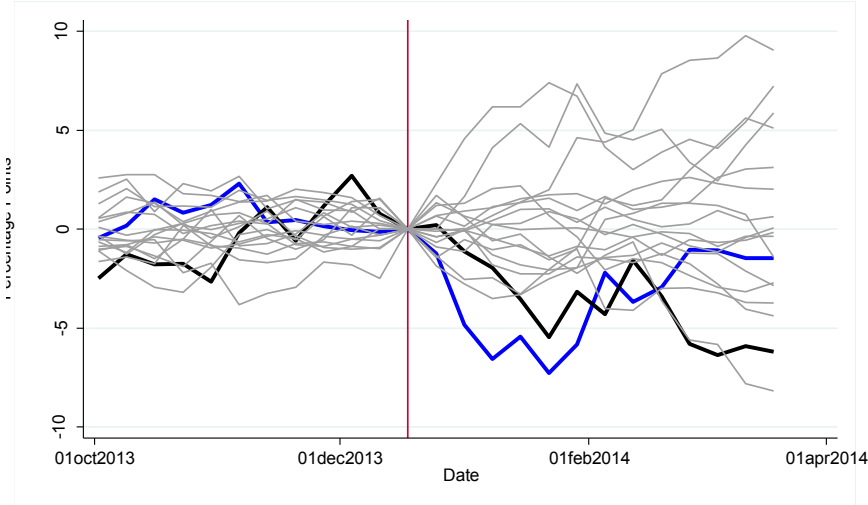
Effect of Program Announcement on Option-Implied Volatility



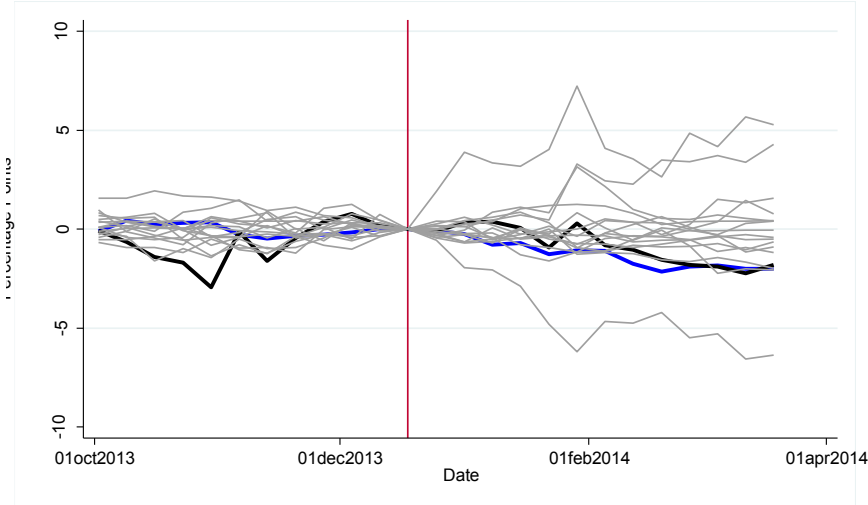
Risk Reversal



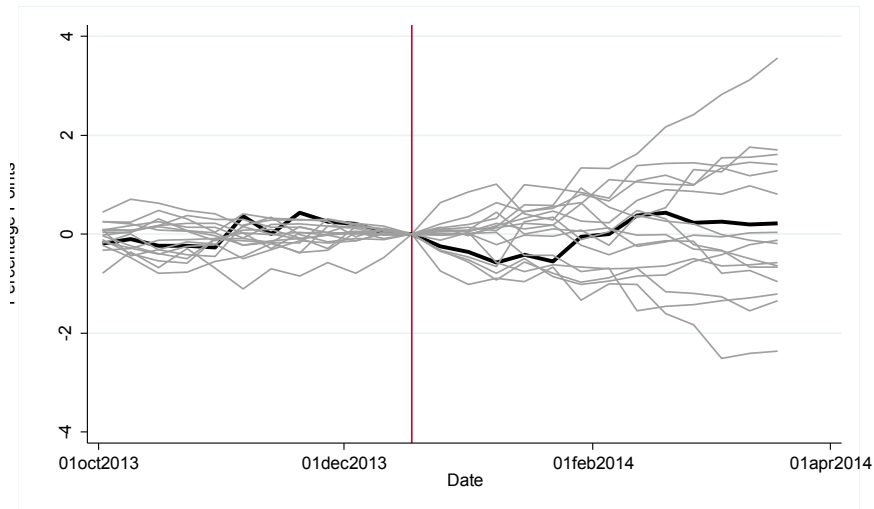
Effect of December 2013 Announcement on Exchange Rate



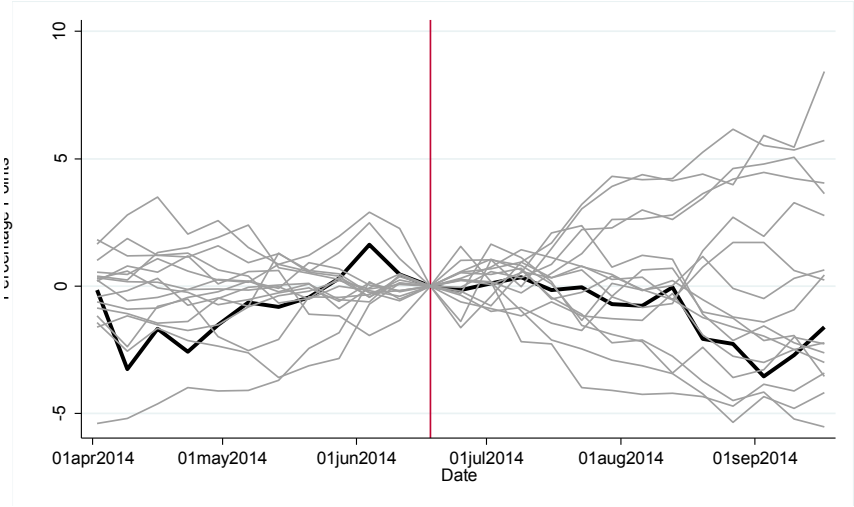
Effect of December 2013 Announcement on Volatility



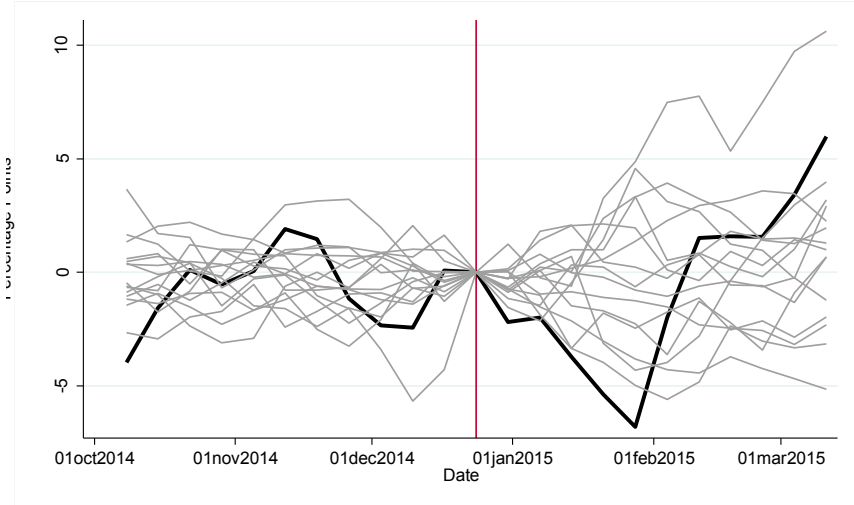
Effect of December 2013 Announcement on Risk Reversal



Effect of June 2014 Announcement on Exchange Rate



Effect of December 2014 Announcement on Exchange Rate

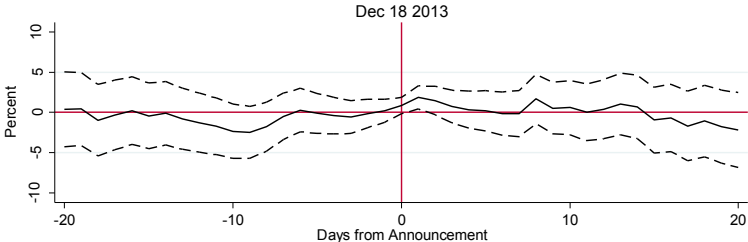
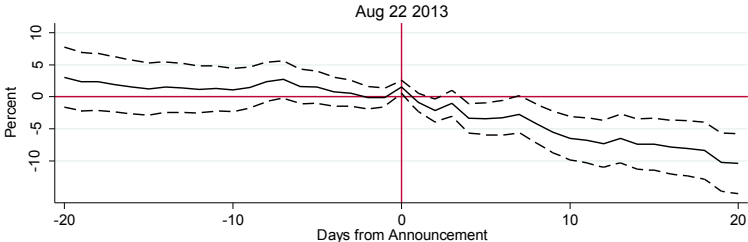


Event Study Regression

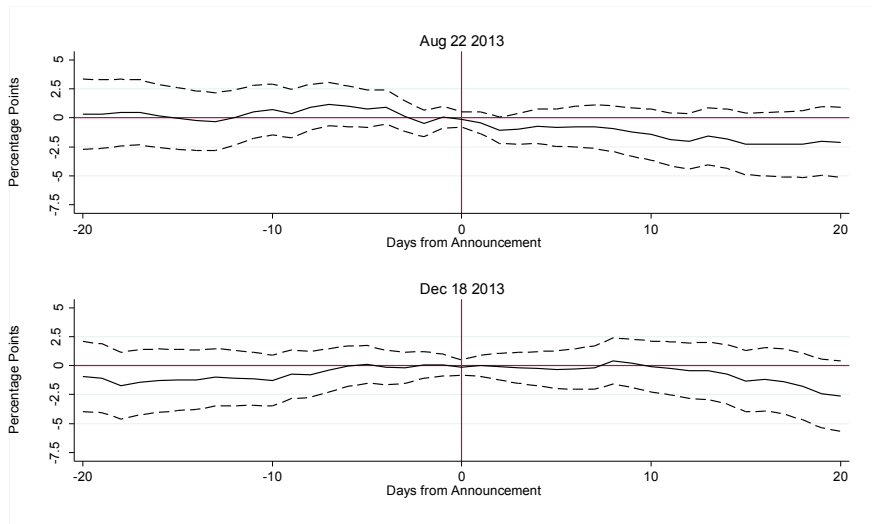
$$\begin{aligned}\Delta \log(e_t) = & c + \gamma_1 \Delta(CDI_t - LIBOR_t) + \gamma_2 \Delta \log(VIX_t) \\ & + \gamma_3 \Delta \log(Commodities_t) + \gamma_4 \Delta \log(DollarIndex_t) \\ & + \gamma_5 \Delta(Dollar - AsiaIndex_t) + \gamma_6 FXInt_t + \varepsilon_t\end{aligned}$$

- ▶ We use daily data to estimate a regression of the change in the log of the exchange rate on:
 - ▶ Change in interest rate differential
 - ▶ Change in $\log(VIX)$
 - ▶ Change in \log CRB commodity prices
 - ▶ Change in \log of a Dollar Index relative to AE; relative to Latin American (excluding Brazil); and relative to Asian currencies
- ▶ Regression estimated using data from January 2013 until 20 days prior to August announcement.
- ▶ Results used to compute changes in exchange rate beyond those implied by fitted model (analogous to Cumulative Abnormal Returns in finance)

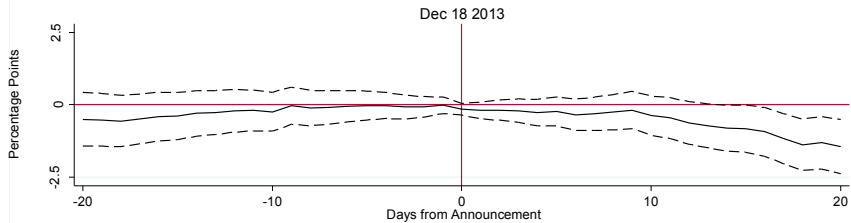
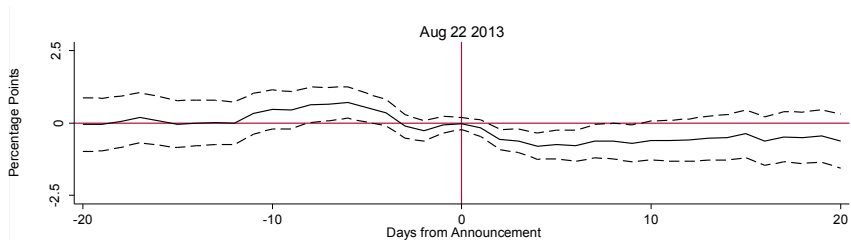
Exchange Rate



Volatility



Risk Reversal



Conclusion

- ▶ Estimates point to a large effect of the program announcement on the exchange rate (10 percentage points)
- ▶ Some estimates point to a decline in option-implied volatility, but results not as stark/robust as for the level
- ▶ Second announcement had a smaller effect on the exchange rate (0-5 percentage points), but not significant
 - ▶ Effect likely priced-in before by the market
- ▶ Third and fourth announcements had virtually no effect.
- ▶ The Brazilian massive intervention program was capable of reverting the exchange rate overshooting in the midst of the Taper Tatum.
- ▶ Such programs should be used only sporadically to calm markets during crises, and not to prevent ER depreciation when economic fundamentals deteriorate.