

# Quantitative Easing and Related Capital Flows into Brazil

Measuring its effects and transmission channels  
through a rigorous counterfactual evaluation

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Joint work with

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- The views expressed here are those of the authors and do not necessarily reflect those of the *Banco Central do Brasil* or its members.

# Motivation

- Possible spillovers from advanced economies (AEs) quantitative easing policies (QE) to emerging market economies (EMEs).
  - Positive growth spillovers highlighted by AEs
  - Negative financial spillovers (and the burden of macro prudential policies) highlighted by EMEs
- Possible role for cross border capital flows
- Brazil a representative and focal point in policy debate
- This paper: (i) Robust evidence of macro and financial spillovers from Fed`s QE policies into Brazil (ii) Robust evidence of the importance of the capital flow channel.

# Intuition

- Forecast domestic variables conditional on foreign policy (10y-3m spread) and foreign variables (CRB, EMBI,..)
  - Interim effect: difference of forecasts conditional on actual and counterfactual scenarios for foreign variables. This is random if the model is unknown.
  - Ex post effect: difference between actual domestic variables and its counterfactual forecast. This is random even if the model is known. Nice test for null effects.
- Grid of counterfactuals ensures robustness
- Multivariate linear model allows channel identification
- Note: to get “effect of interest” and “channel of interest” must include relevant variables...

# Roadmap

- Motivation / Intuition
- Literature / Contribution
- Definitions / Propositions
- Model / Results
- Summary

# Literature

- Counterfactual term spread: Pesaran and Smith (2012), Baumeister and Benati (2013), Chen *et.al.* (2012); large counterfactuals up to 200 bps; usually no test.
- Event study: Gagnon *et.al.* (2011), D'Amico and King (2010), Krishnamurthy *et.al.* (2011), Bauer (2012), Williams (2011)); around 100 bps (QE1) or 30 bps (QE2) upon announcement.
- Arbitrage free: D'Amico and King (2010), Hamilton and Wu (2012), Jarrow and Li (2012)); 75 bps for both QE1 and QE2.
- Other foreign variables: Neely (2012); Kim (2001); Anzuini, Lombardi and Pagano (2013); Bastourre *et.al.* (2012).
- Capital flows: BIS (2008), BIS-CGFS (2009), the IDB (2012); less benign view of capital flows

# Contribution

- General:

- Decomposition of the transmission channels
- Test ex post effects pooling information across events.
- Agnostic principle when defining counterfactuals

- Specific:

- Estimation and test of spillover effects over more than 50 variables in the Brazilian economy
- Quantitative assessment of the capital flow channel for these effects

# Notation

- $y_t$  domestic variable
- $x_t$  foreign policy (eg. term spread)
- $z_t$  global variable (eg. CRB, EMBI)
- $\Omega_t$  their history up to period  $t$
- $x_{t,h}^p$  with  $p \in \{a, c\}$  actual or counterfactual policy up to period  $t + h$ .
- Similarly for global variables  $z_{t,h}^a, z_{t,h}^c$

# Definitions

$$\text{➤ } d_{t+h}^{interim} = E(y_{t+h} | \Omega_t, x_{t,h}^a, z_{t,h}^a) - E(y_{t+h} | \Omega_t, x_{t,h}^c, z_{t,h}^c)$$

$$\text{➤ } d_{t+h}^{ex post} = y_{t+h} - E(y_{t+h} | \Omega_t, x_{t,h}^c, z_{t,h}^c)$$

$$\text{➤ } AIE = \frac{1}{H} \sum_{h=1}^H d_{t+h}^{interim}$$

$$\text{➤ } AEE = \frac{1}{H} \sum_{h=1}^H d_{t+h}^{ex post} = AIE + \frac{1}{H} \sum_{h=1}^H \varepsilon_{t+h}$$

➤ How to set counterfactual global variables? Our proposal:

$$\text{➤ } z_{t+j}^c = z_{t+j}^a + \lambda \{ E(z_{t+j} | \Omega_t, x_{t,h}^a) - E(z_{t+j} | \Omega_t, x_{t,j}^c) \}$$

➤ Note: if the policy is anticipated must adapt notation so that forecast  $j < h$  steps ahead uses policy information up to  $h$ . we do not consider this case in the paper.

# Tests

➤  $H_0: AEE_r = 0 \Rightarrow t_r = \frac{1}{\hat{\sigma}_r} AIE_r \sim N(0,1)$

➤ Pool information on policy rounds

➤  $H_0: \sum_r AEE_r / R = 0$  pooled average is zero

$$t_{pool} = (\overline{\hat{\sigma}^2})^{-\frac{1}{2}} \frac{1}{R} \sum_{r=1}^R AIE_r \sim N(0,1)$$

➤  $H_0: (\forall r) AEE_r = 0$  each average is zero

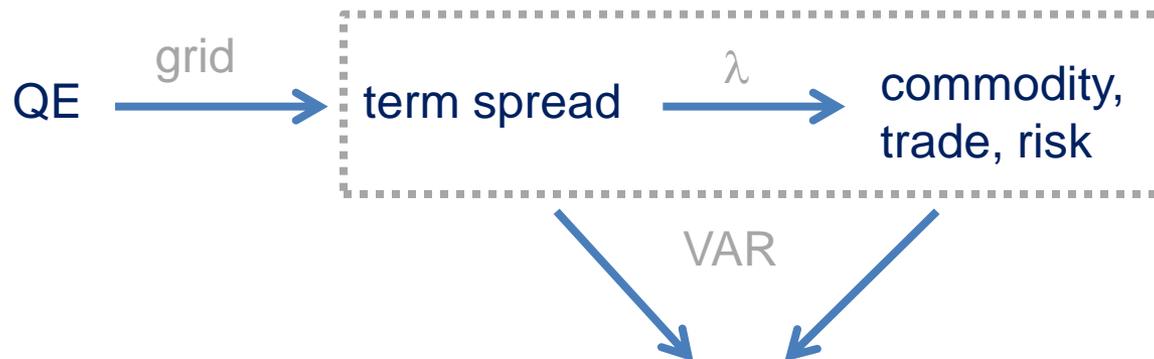
$$t_{each} = \sum_{r=1}^R \frac{1}{\hat{\sigma}_r^2} (AIE_r)^2 \sim \chi^2_{(R)}$$

➤ Note: similar in the cross section as well

# Channel Decomposition

- Let the domestic variables be  $y=(y_1,\dots,y_n)$ .
- Conditional expectations from a Vector Autoregression
- As before, the *ex ante effect* uses the counterfactual foreign variables in each VAR equation to project the full scenario.
- Now, let the *marginal ex ante effect* of  $y_i$  uses the counterfactual policy only in the equation for  $y_i$
- Proposition:
  - For a linear conditional model, the *ex ante effect* is the sum of the *marginal ex ante effects*.

# Empirical Strategy in a Nutshell



core: inflation, activity, gross capital inflow,  
policy rate, exchange rate

additional: credit, credit risk, interest rate,  
spread, stock market, etc.. (50  
variables)



propagation  
through  
domestic  
channels

Note: Ideally, liquidity shocks should be the overwhelming driver the term spread in the sample, so that on average we get the right effects.

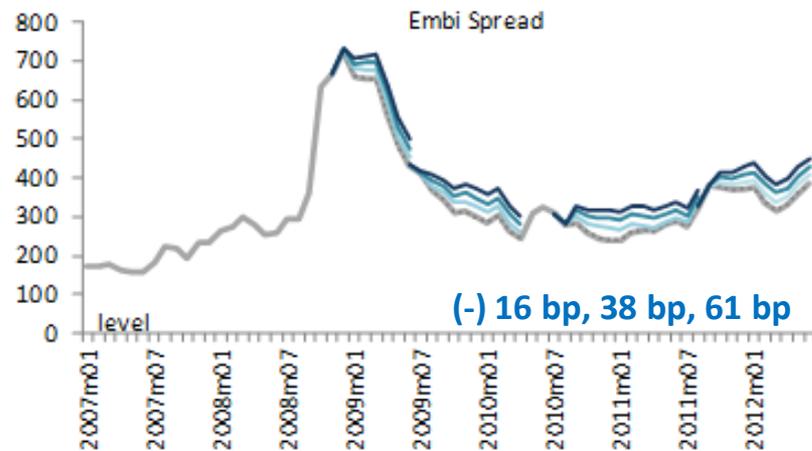
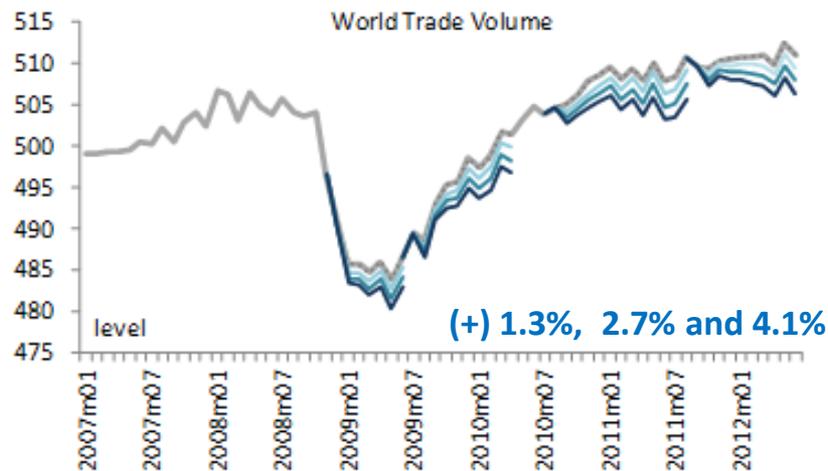
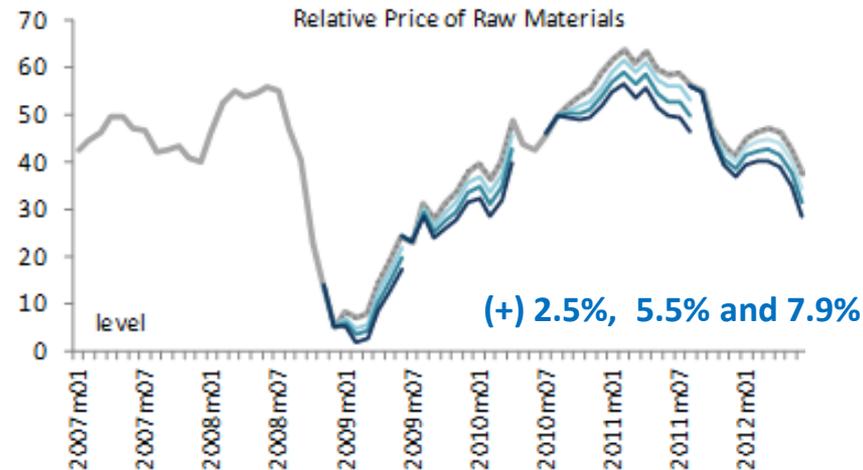
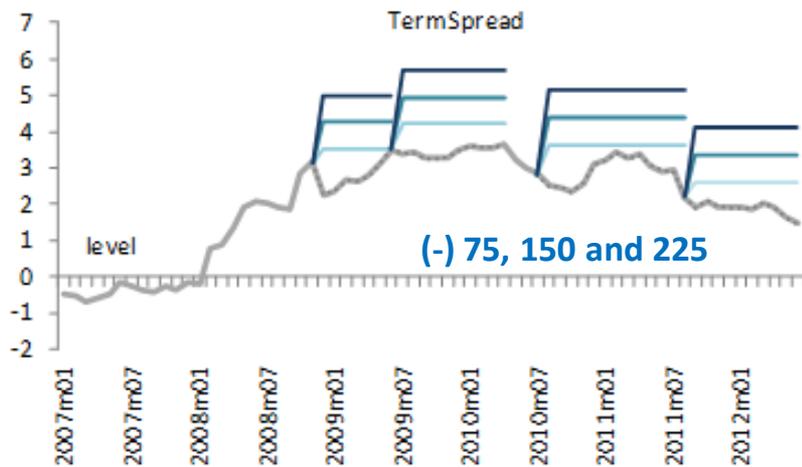
# VAR Specification

- VAR in levels (possible cointegration, parsimonious)
  - In particular, accumulated gross capital flows.
- Parameter stability according to fluctuation tests.
- Just to make sure, we report results for two samples:
  - Full sample: Jan 2000-Jun 2012;
  - Crisis sample: Jan 2006-Jun 2012.
    - Two years before NBER peak;
    - This allows forward looking behavior;
    - And avoids small sample problems.
- Extended VAR as in Kim (2001) and Jansen (2003).

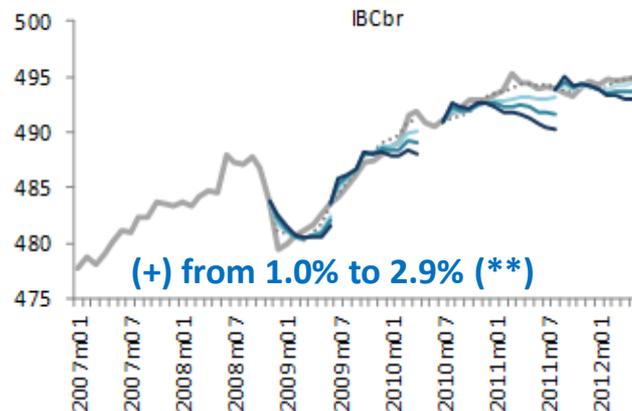
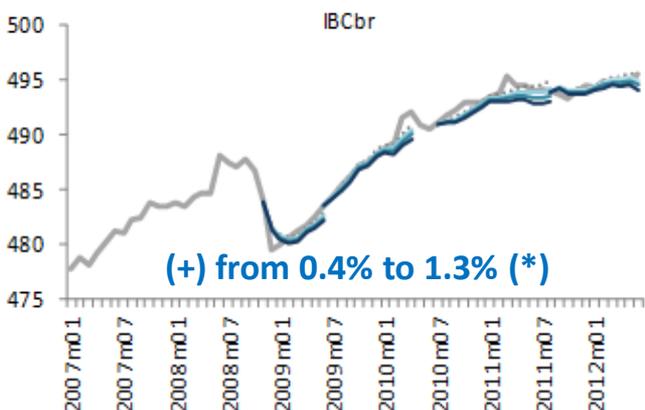
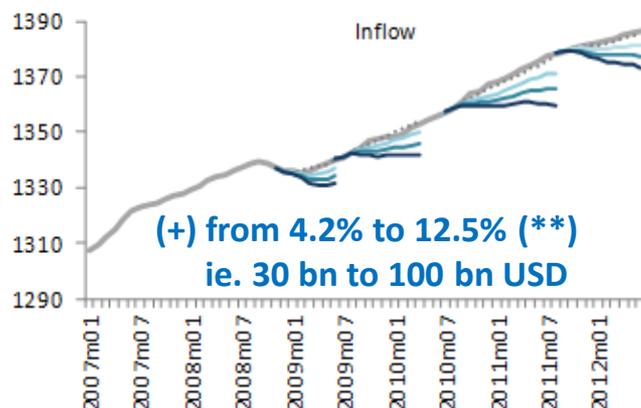
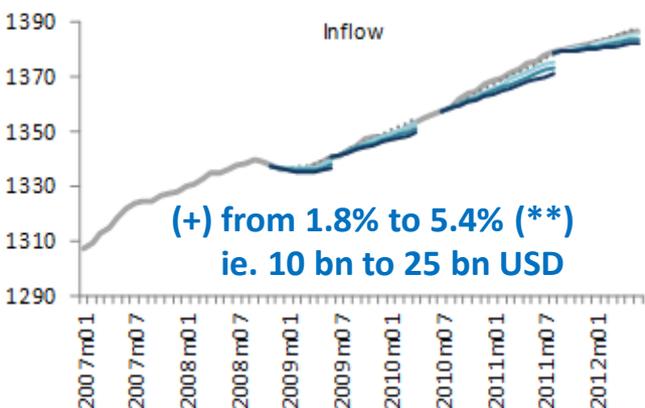
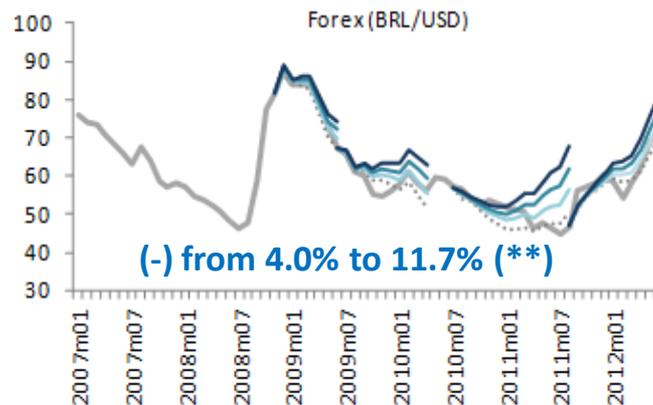
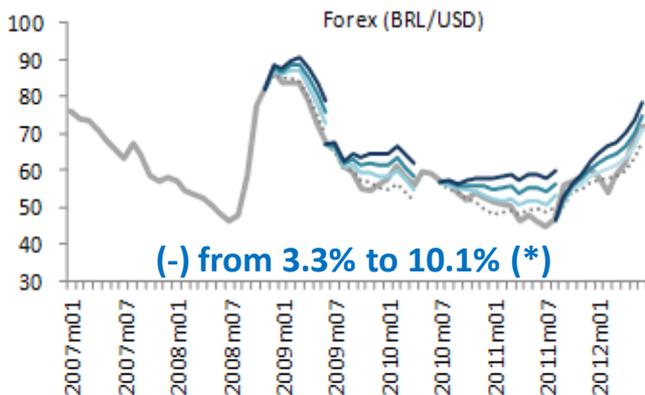
# Counterfactual Scenarios

- QE1 - Dec 2008 to Jun 2009;
- QE1 extension - Jul 2009 to Apr 2010;
- QE2 - Aug 2010 to Aug 2011;
- Operation Twist - Sep 2011 to Jun 2012.
  
- We investigate a grid in the range of the literature:
  - From 75 to 225 basis points effect on the term spread.
  - For each of these, deduce the likely behavior of foreign variables, given historical correlations ( $\lambda=1$ )
    - Somewhat conservative, could use stressed correlations as suggested by the IMF
    - We actually do so as a robustness exercise

# Counterfactual Scenarios



# Effects on the Core Variables



Ex Ante Effect = relative to dotted line

Ex Post Effect = relative to actual series

LHS = Full Sample

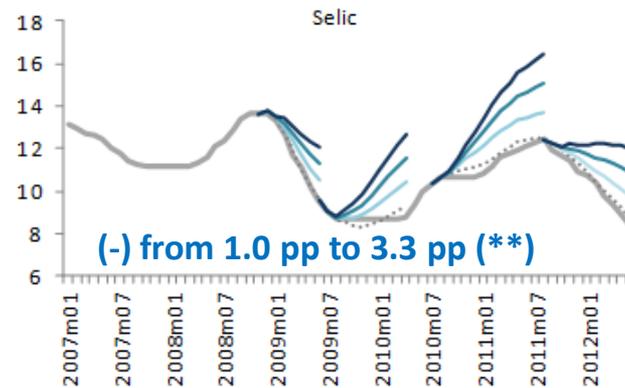
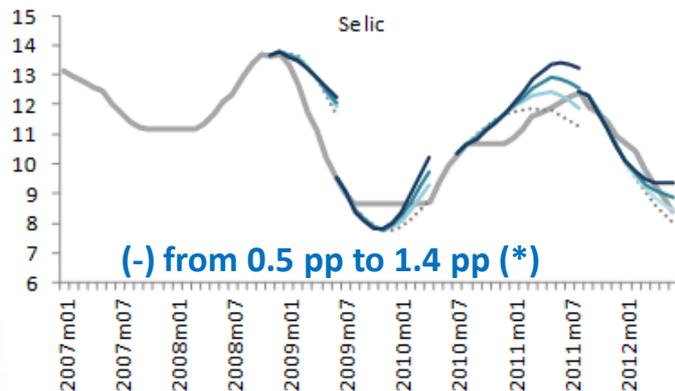
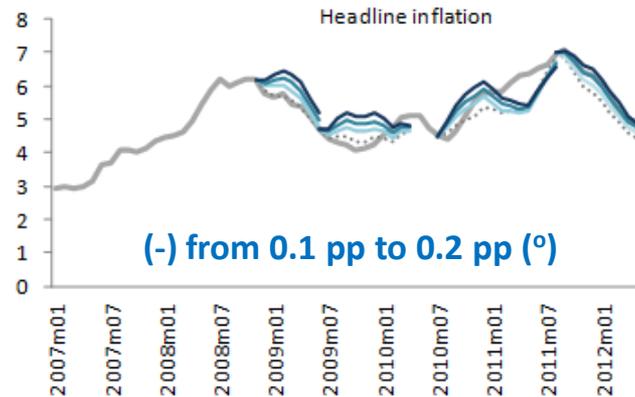
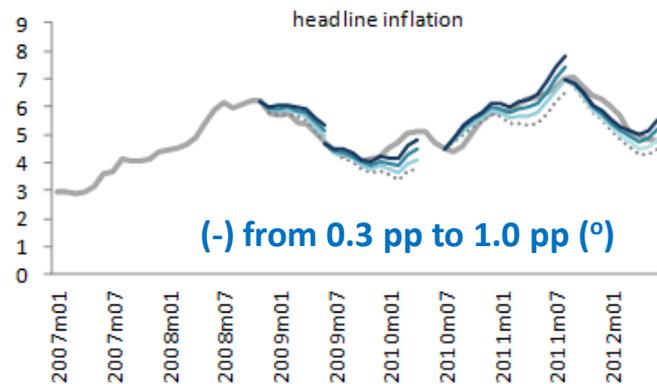
RHS = Crisis Sample

\*\* = sign at 5%

\* = sign at 10%

o = not sign

# Effects on Core Variables



Ex Ante Effect =  
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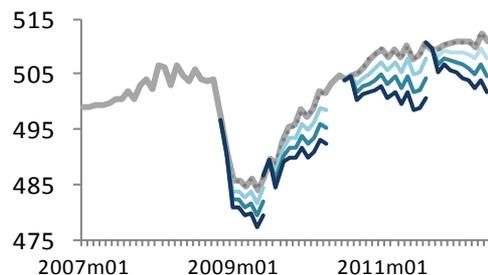
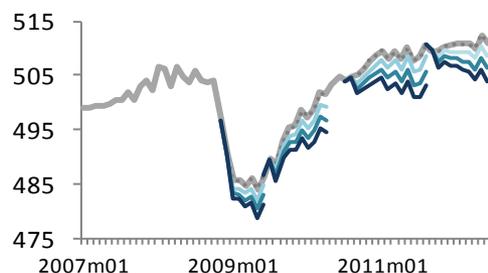
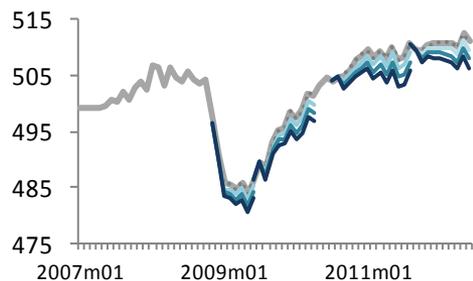
\*\* = sign at 5%

\* = sign at 10%

° = not sign

# Higher Global Correlation Exercise

**Counterfactuals on world trade**  
*Stronger priors on global activity channel*



## Accumulated Ex Ante Effect

Average across QE rounds

Full Sample  
 2000m01 to 2012m06

| <i>lambda</i> = 1.0 | 75    | 100   | 125   | <b>150</b> | 175   | 200   | <b>225</b> |
|---------------------|-------|-------|-------|------------|-------|-------|------------|
| Price               | -0.34 | -0.45 | -0.56 | -0.67      | -0.78 | -0.89 | -1.00      |
| Activity            | 0.43  | 0.57  | 0.71  | 0.85       | 0.98  | 1.12  | 1.26       |
| Inflow              | 1.79  | 2.38  | 2.98  | 3.58       | 4.18  | 4.78  | 5.37       |
| Selic (p.p)         | -0.46 | -0.61 | -0.76 | -0.90      | -1.05 | -1.20 | -1.35      |
| Forex               | -3.26 | -4.41 | -5.55 | -6.69      | -7.84 | -8.98 | -10.13     |

| <i>lambda</i> = 1.5 | 75    | 100   | 125   | <b>150</b> | 175   | 200   | <b>225</b> |
|---------------------|-------|-------|-------|------------|-------|-------|------------|
| Price               | -0.13 | -0.17 | -0.21 | -0.26      | -0.30 | -0.35 | -0.39      |
| Activity            | 0.44  | 0.58  | 0.72  | 0.87       | 1.01  | 1.15  | 1.29       |
| Inflow              | 1.23  | 1.64  | 2.06  | 2.48       | 2.90  | 3.32  | 3.74       |
| Selic (p.p)         | -0.22 | -0.30 | -0.37 | -0.44      | -0.51 | -0.58 | -0.65      |
| Forex               | -2.29 | -3.11 | -3.94 | -4.77      | -5.59 | -6.42 | -7.24      |

| <i>lambda</i> = 2.0 | 75    | 100   | 125   | <b>150</b> | 175   | 200   | <b>225</b> |
|---------------------|-------|-------|-------|------------|-------|-------|------------|
| Price               | 0.08  | 0.11  | 0.13  | 0.15       | 0.17  | 0.19  | 0.22       |
| Activity            | 0.44  | 0.59  | 0.74  | 0.88       | 1.03  | 1.18  | 1.33       |
| Inflow              | 0.66  | 0.91  | 1.15  | 1.39       | 1.63  | 1.87  | 2.12       |
| Selic (p.p)         | 0.01  | 0.02  | 0.02  | 0.03       | 0.03  | 0.04  | 0.04       |
| Forex               | -1.31 | -1.82 | -2.33 | -2.84      | -3.34 | -3.85 | -4.36      |

# Effects on Other Variables

## ➤ Credit

- Credit/GDP: (+) 0.2 pp to 0.6 pp (\*\*) 0.4 pp to 1.0 pp (°)
- Interest rates: (-) 1.0 pp to 3.0 pp (\*\*) 2.0 pp to 6.9 pp (\*\*)
- Credit at risk: (-) 0.1 pp to 0.2 pp (°) 0.3 pp to 0.9 pp (\*\*)

## ➤ Stock Market

- Market Cap/GDP: (+) 3.2 pp to 10.0 pp (\*\*) 5.5 pp to 17.0 pp (\*\*)
- Funds Cap/GDP: (+) 0.4 pp to 1.3 pp (\*\*) 0.6 pp to 1.8 pp (\*\*)

## ➤ Inflation

- Producer Price: (-) 1.8 pp to 5.4 pp (\*) 0.8 pp to 2.6 pp (\*\*)

## ➤ External Sector

- Portfolio inflow: (+) 2.8% to 8.6% (\*\*) 6.7% to 19.6% (\*\*)
- Int.Reserves: (+) 0.7 pp to 2.0 pp (\*\*) 1.6 pp to 4.7 pp (\*\*)

## ➤ Domestic Sector

- Retail Sales: (+) 1.0% to 2.8% (°) 1.5% to 4.2% (\*\*)
- Ind.Prod.: (+) 0.0 pp to 0.2 pp (°) 1.2 % to 3.7% pp (\*\*)

# Test for Ex Post Effects

## Crisis Sample

Null Hypothesis: Each average ex-post effect = 0  
p-values for ChiSq(4) test statistics

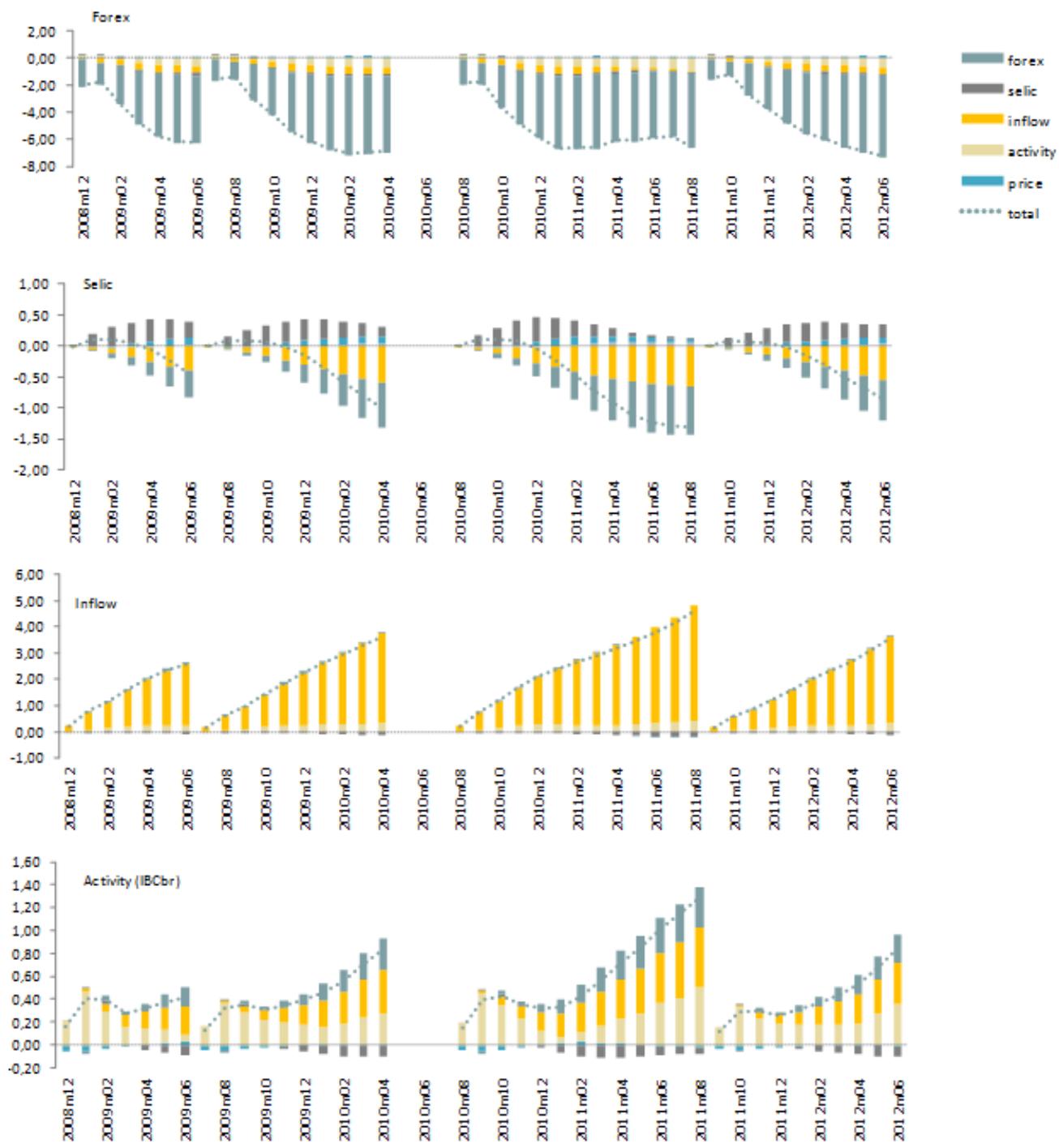
Crisis Sample  
2006m01 to 2012m06

|  | 75   | 100  | 125  | 150  | 175  | 200  | 225  |
|--|------|------|------|------|------|------|------|
| Price  | 0,46 | 0,29 | 0,16 | 0,08 | 0,03 | 0,01 | 0,00 |
| Activity                                     | 0,81 | 0,66 | 0,47 | 0,30 | 0,17 | 0,08 | 0,03 |
| Inflow                                       | 0,12 | 0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Selic  | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Forex  | 0,98 | 0,96 | 0,92 | 0,85 | 0,77 | 0,67 | 0,57 |
| non ear marked credit (%gdp)                 | 0,88 | 0,76 | 0,61 | 0,45 | 0,30 | 0,18 | 0,10 |
| non ear marked credit; firms                 | 0,86 | 0,75 | 0,62 | 0,48 | 0,35 | 0,23 | 0,15 |
| non ear marked credit; households            | 0,48 | 0,20 | 0,06 | 0,01 | 0,00 | 0,00 | 0,00 |
| credit from private banks                    | 0,84 | 0,66 | 0,46 | 0,28 | 0,14 | 0,07 | 0,03 |
| credit from private banks; households        | 0,31 | 0,09 | 0,01 | 0,00 | 0,00 | 0,00 | 0,00 |
| credit from private banks; manufacture       | 0,88 | 0,75 | 0,57 | 0,40 | 0,25 | 0,14 | 0,07 |
| credit from private banks; retail            | 1,00 | 1,00 | 1,00 | 0,99 | 0,99 | 0,99 | 0,98 |
| credit from foreign banks                    | 0,49 | 0,26 | 0,10 | 0,03 | 0,01 | 0,00 | 0,00 |
| credit from foreign banks; households        | 0,63 | 0,36 | 0,16 | 0,05 | 0,01 | 0,00 | 0,00 |
| credit from foreign banks; manufacture       | 0,88 | 0,75 | 0,58 | 0,41 | 0,26 | 0,15 | 0,07 |
| credit from foreign banks; retail            | 0,81 | 0,66 | 0,50 | 0,35 | 0,22 | 0,13 | 0,07 |
| credit at risk; D or worse (p.p)             | 0,72 | 0,47 | 0,25 | 0,10 | 0,03 | 0,01 | 0,00 |
| credit at risk; D or worse; households       | 0,98 | 0,95 | 0,92 | 0,86 | 0,79 | 0,70 | 0,61 |
| credit at risk; D or worse; manufacture      | 0,87 | 0,73 | 0,56 | 0,38 | 0,23 | 0,12 | 0,06 |
| credit at risk; D or worse; manuf+retail     | 0,18 | 0,04 | 0,01 | 0,00 | 0,00 | 0,00 | 0,00 |
| interest rate; reference loans (p.p.)        | 0,89 | 0,76 | 0,59 | 0,41 | 0,26 | 0,14 | 0,07 |
| interest rate; reference loans; households   | 0,77 | 0,61 | 0,42 | 0,26 | 0,14 | 0,07 | 0,03 |
| interest rate; reference loans; firms        | 0,32 | 0,12 | 0,03 | 0,01 | 0,00 | 0,00 | 0,00 |
| interest rate spread; reference loans        | 0,98 | 0,95 | 0,92 | 0,86 | 0,79 | 0,70 | 0,61 |
| interest rate spread; reference loans; firms | 0,89 | 0,79 | 0,65 | 0,50 | 0,35 | 0,22 | 0,13 |
| stock market funds (%gdp)                    | 0,21 | 0,05 | 0,01 | 0,00 | 0,00 | 0,00 | 0,00 |
| stock market value                           | 0,70 | 0,47 | 0,26 | 0,12 | 0,05 | 0,01 | 0,00 |
| headline price index; services               | 0,71 | 0,54 | 0,37 | 0,22 | 0,12 | 0,06 | 0,02 |
| headline price index; food                   | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| headline price index; core                   | 0,13 | 0,04 | 0,01 | 0,00 | 0,00 | 0,00 | 0,00 |
| producer price index                         | 0,95 | 0,89 | 0,81 | 0,70 | 0,57 | 0,44 | 0,33 |
| gross inflow; acm; direct investment         | 0,78 | 0,65 | 0,50 | 0,35 | 0,23 | 0,14 | 0,07 |
| gross inflow; acm; portfolio                 | 0,19 | 0,04 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| gross inflow; acm; credit                    | 0,34 | 0,12 | 0,03 | 0,00 | 0,00 | 0,00 | 0,00 |
| export quantum                               | 0,77 | 0,61 | 0,44 | 0,29 | 0,17 | 0,09 | 0,04 |
| import quantum                               | 0,73 | 0,54 | 0,35 | 0,19 | 0,09 | 0,04 | 0,01 |
| import quantum; intermediate                 | 0,82 | 0,69 | 0,53 | 0,37 | 0,23 | 0,13 | 0,07 |
| international reserves (%gdp)                | 0,07 | 0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| international reserves (%m2)                 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| unemployment rate                            | 0,88 | 0,78 | 0,65 | 0,52 | 0,38 | 0,26 | 0,17 |
| formal employment; retail and service        | 0,89 | 0,79 | 0,66 | 0,51 | 0,36 | 0,23 | 0,14 |
| formal employment; construction              | 0,36 | 0,16 | 0,06 | 0,02 | 0,00 | 0,00 | 0,00 |
| retail sales                                 | 0,46 | 0,25 | 0,11 | 0,04 | 0,01 | 0,00 | 0,00 |
| retail sales; hypermarkets                   | 0,52 | 0,32 | 0,17 | 0,08 | 0,03 | 0,01 | 0,00 |
| auto sales                                   | 0,80 | 0,65 | 0,48 | 0,32 | 0,20 | 0,11 | 0,05 |
| industrial production                        | 0,45 | 0,23 | 0,09 | 0,03 | 0,01 | 0,00 | 0,00 |
| industrial production; consumption goods     | 0,67 | 0,47 | 0,28 | 0,14 | 0,06 | 0,02 | 0,01 |
| fixed capital absorption                     | 0,27 | 0,11 | 0,03 | 0,01 | 0,00 | 0,00 | 0,00 |
| inputs to civil construction                 | 0,77 | 0,61 | 0,44 | 0,28 | 0,16 | 0,09 | 0,04 |
| installed capacity utilization               | 0,67 | 0,46 | 0,27 | 0,13 | 0,05 | 0,02 | 0,00 |

# Decomposition: Core Variables

Full sample

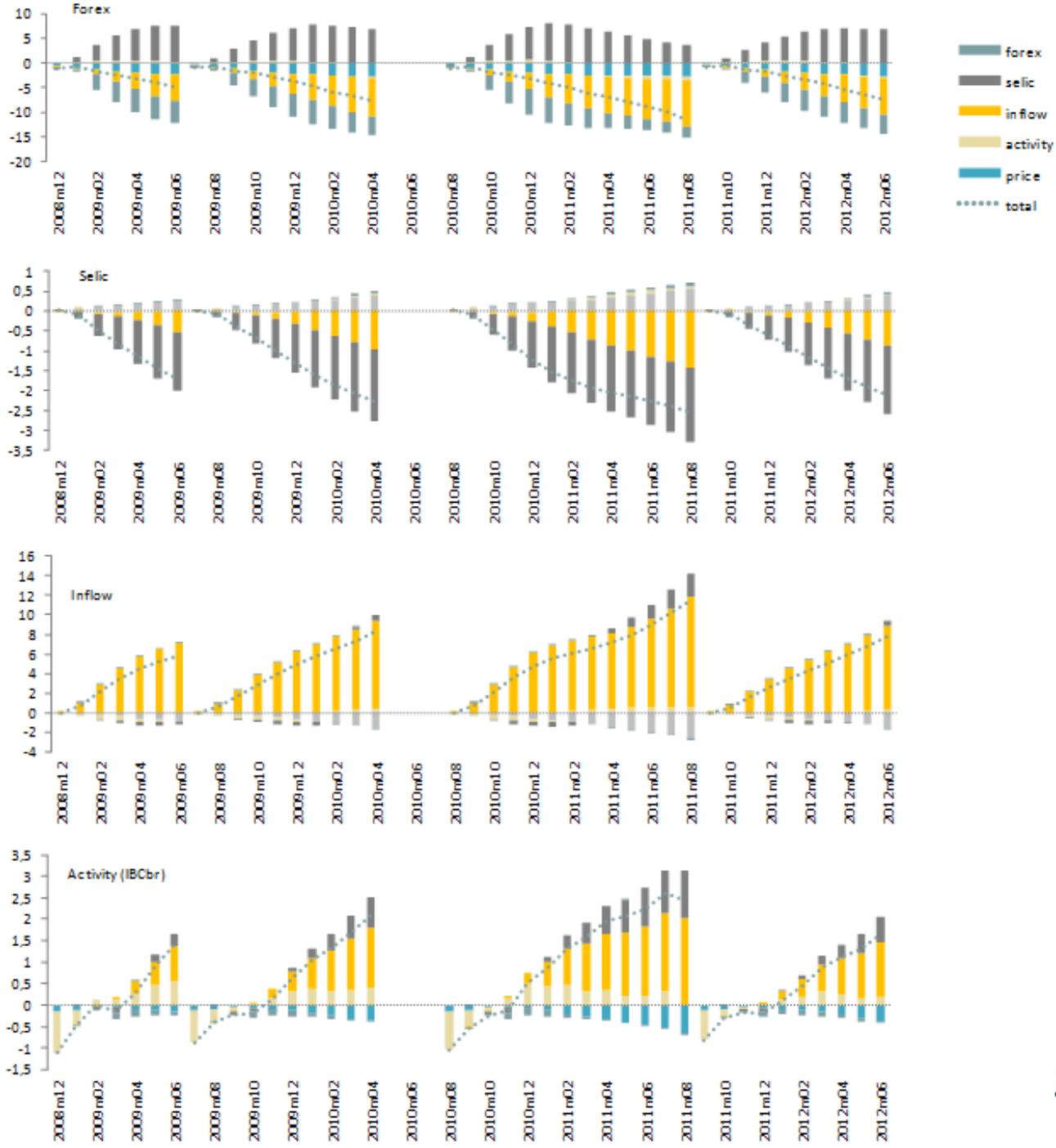
150 bp counterfactual



# Decomposition: Core Variables

## Crisis Sample

150 bp counterfactual



# Caveat for Channel Decomposition

- Brazil implemented macroprudential policies
- Not included in the model
- However, should weaken the capital inflow channel
- Therefore, if anything, our channel estimation for capital flow is biased downwards, which strengthens our results.

# Summary of Interim Effects

- QE has foreseeable spillover effects on the Brazilian economy:
  - large capital inflows;
  - exchange rate appreciation;
  - stock market price increases;
  - credit market boom;
  - stronger activity.
- This is consistent with EME policy makers argument of financial instability; but also with AE argument of growth spillovers.
  - The main message is that there are “collateral effects”.
- No robust conclusion on inflation

# Summary of Ex post Effects

- Moreover, the actual difference between events and counterfactuals is statistically significant.
  - According to the evidence for the crisis sample.
  - For the test with the following alternative
    - At least one QE policy round had effects;
- Our test, which uses multiple policy rounds, has more power than previous ones suggested in the literature.

# Summary of Transmission Channels

- Capital inflow is the most important transmission or propagation channel
  - Robust statistical significance across samples
  - Higher proportional contribution to the propagation
  - More than 2/3 of the effects propagate through the domestic capital inflow channel.

# Further work

- We are applying similar methods in new research such as:
  - Explore the cross-section information when conducting inference in the context of Panel VAR models.
  - Estimate the effect of domestic macro prudential and other domestic intervention policy.
    - In particular, we are exploring both fronts to assess the consequences of tapering by the Fed.
    - In this respect, the results in this paper are suggestive.
    - But further work is necessary possible changes in the data generating process.

**Thank you!**

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