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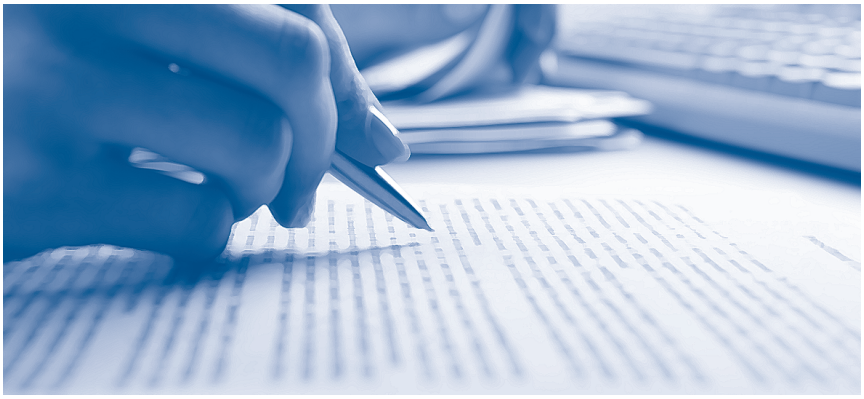

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Quantitative Easing and Related Capital Flows into Brazil: measuring its effects and transmission channels through a rigorous counterfactual evaluation‡

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Abstract

The Working Papers should not be reported as representing the views of the Banco Central do Brasil. The views expressed in the papers are those of the author(s) and do not necessarily reflect those of the Banco Central do Brasil.

This paper investigates whether quantitative easing policies produces spillover effects from advanced economies into emerging markets affecting prices and asset markets, and, if so, how much of these effects is attributed to "excessive" capital inflows. We focus on the Brazilian economy and on quantitative easing (QE) policies adopted by the Federal Reserve. Our evaluation methodology is an extension of Pesaran and Smith (2012) and estimates *ex-ante* and *ex-post* policy effects over a grid of counterfactuals. We also provide a decomposition of the transmission channels of the policy effects, and test for their statistical significance. The decomposition method is novel and stems from a vector autoregressive model of the endogenous variables where the different channels are represented. Our results are consistent with the view that QE policies had a positive effect on growth but also had other significant spillover effects on the Brazilian economy. These effects were mostly transmitted through "excessive" capital inflows that led to exchange rate appreciation, stock market price increases and a credit boom. The effect on inflation was less robust, mitigated by currency appreciation and dependent on whether global activity reacts more strongly to quantitative easing.

JEL Classification: C18, C54, E52, E58, E65, F31, F37.
Keywords: Capital Flows, Quantitative Easing, Counterfactuals, Brazil.

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‡ This paper was presented at the "*Technical Seminar on Spillover Methodologies*" on the occasion of the IMF and World Bank Spring Meetings, on April 21, 2013. This paper was written before any signaling about possible exit and unwinding from unconventional monetary policies; therefore it does not address its policy challenges and consequences. The findings of this paper on the impacts of QE conducted during the phase of increase of asset purchase programs should not be interpreted as mechanically symmetrical and with opposite signs during the phase of a possible tapering and/or reduction of these asset purchase programs.

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1. Introduction

Quantitative easing (QE) policies and its effects have become a hotly debated subject among policy makers and academics in the post-crisis environment. There is a controversy as to the effectiveness and possible global spillovers of such "unconventional" monetary policy measures, and the debate features prominently in the Group of Twenty (the G20), a major international forum for policy coordination. Emerging market policy makers point out that a possible important side effect of QE is "excessive" capital inflows under various forms of carry-trade which in turn triggers excessive growth in domestic asset prices and in local financial system aggregates.[1] Advanced economies policy makers argue that quantitative easing policies are aimed at sustaining growth and avoided extreme negative events, therefore supporting growth in emerging market economies as well.[2] Apart from QE's announcement effects on financial variables, which can be observed empirically and in an almost real-time fashion, academics are mostly skeptical about reaching final conclusions on any effect of QE without formal evaluation models and, in particular, point to the difficult construction of a compelling counterfactual argument.

This paper proceeds in the Heckman tradition of building counterfactuals for policy evaluation.[3] We investigate if quantitative easing policies have produced spillover effects on emerging markets, and, if so, how much of these effects could be attributed to "excessive" capital inflows. We focus on the Brazilian economy and on quantitative easing policies adopted by the Federal Reserve. Our evaluation methodology is an extension of Pesaran and Smith (2012) and estimates *ex-ante* and *ex-post* policy effects over a grid of counterfactuals. We also provide a novel decomposition of the transmission channels, which results from a vector autoregressive model of the endogenous variables where the different channels are represented. The estimated effects and transmission channels are

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[1] The BRICS countries stated that "*excessive liquidity from the aggressive policy actions taken by central banks to stabilize their domestic economies have been spilling over into emerging market economies, fostering excessive volatility in capital flows and commodity prices. (...) We believe that it is critical for advanced economies to adopt responsible macroeconomic and financial policies, avoid creating excessive global liquidity and undertake structural reforms to lift growth that create jobs. We draw attention to the risks of large and volatile cross-border capital flows being faced by the emerging economies,*" at the Fourth BRICS Summit: Delhi Declaration, New Delhi, March 29, 2012.

[2] The G7 Finance Ministers and Central Bank Governors have stated "*The G7 Ministers and Governors, reaffirm (their) longstanding commitment to market determined exchange rates and to consult closely in regard to actions in foreign exchange markets. We reaffirm that our fiscal and monetary policies have been and will remain oriented towards meeting our respective domestic objectives using domestic instruments, and that we will not target exchange rates. We agreed that excessive volatility and disorderly movements in exchange rates can have adverse implications for economic and financial stability",* in the preparation to the G20 meeting in Moscow, February 15-16, 2013.

[3] By counterfactual we mean what would have happened if the policy were different than that prevailing at the time. For inference, one explores similar individuals or recurring time patterns.

tested for their statistical significance, an important step that is not very common in counterfactual analysis. We propose two novel statistical tests which have more power than previously available ones. The method is applied to a large set of domestic variables and allows for possible structural breaks. Concerning the literature, we adopt a more agnostic position, without taking a particular stance on the proper counterfactual, and explore robustness results across a range of policy counterfactuals. Therefore, we are able to highlight rigorous and robust results across a range of specifications with the necessary scope to evaluate how "destabilizing" has been quantitative easing and corresponding capital inflows into Brazil.

Just to give an example of the importance of quantitative easing measures,[4] recently the Federal Reserve Bank (Fed) has announced the so-called QE3 in which he commits itself into buying USD40 billion monthly of mortgage backed securities (MBS), considering additional asset purchases as well as resort to other policy options until the economy recovers. In addition, last December, the Fed converted its purchases of long-term Treasuries under the maturity extension program ("Operation Twist"), into open-ended purchases. That means that it will stop the sale of short-term securities at year-end while continuing its purchases of long-term Treasury securities (USD45 billion) per month. The Fed implemented numerical thresholds for its policy rate guidance, anticipating that exceptionally small federal funds rates will be appropriate at least as long as "*the unemployment rate remains above 6-1/2 percent, inflation between one and two years ahead is projected to be no more than a half percentage point above the Committee's percent longer-run goal, and longer-term inflation expectations continue to be well anchored*."

The European Central Bank (ECB) has announced the Outright Monetary Transactions (OMT) program and broadened its collateral requirements. Moreover, this is a conditional program without any limits set in advance, both in terms of volume and duration, in which the ECB commits itself into buying bonds from countries in need as long as those countries formally ask for help and agree to undergo a macroeconomic adjustment or precautionary program with the EFSF/ES (European Financial Stability Facililty/European Stability Mechanism). The Bank of England (BoE) has expanded its quantitative easing program and has implemented some innovative measures. For example, under its Funding for Lending Scheme (FLS) banks and building societies will be able to

[4] There have been many instances of unconventional monetary policy implemented or announced as we were writing. This reflects the fact that conventional monetary policy has lost most of its room for maneuver after hitting the Zero Lower Bound. In that context, a central bank implements QE by buying financial assets, creating money and injecting a pre-determined (or open-ended) quantity of liquidity into the economy.

borrow Treasury bills in exchange for less liquid collateral, increasing the quality of assets held by banks. Also, swap fees will be lower for those banks that maintain or expand their lending, creating extra incentives for lending. Another example is the Bank of Japan (BoJ) that has increased its asset purchasing program by 10 trillion yen and extended its deadline by six months to the end of 2013. It estimates a monetary expansion of almost five percent of GDP in 2013. In addition, last January the BoJ has decided to introduce an open-ended asset purchasing method under the Asset Purchase Program (APP) starting in 2014. Finally, on April 4, 2013, the BoJ stepped up its APP and explicitly announced a bold and unprecedented monetary stimulus aiming at injecting about USD1.4 trillion into the economy in less than two years and doubling the monetary base to 270 trillion yen (USD2.9 trillion) by the end of 2014, a radical move that sent the yen reeling and bond yields to record lows. The policy was explicitly aimed at boosting growth and lifting inflation expectations; given its relative size, it is unmatched in scope even by the U.S. Federal Reserve's own quantitative easing program.[5]

In order to evaluate the possible global spillovers from ongoing unconventional monetary policies, it is important to look at the track record of previous rounds of quantitative easing. Accordingly, we investigate policy rounds conducted by the Federal Reserve from December 2008 to June 2012. We focus on these episodes for three main reasons: (a) the relative importance of the United States to the Brazilian economy, by geographical distance, flow of funds and trade; (b) the relative economic and monetary size of the United States in the global economy; and (c) the existence of significant prior event studies regarding these episodes, which are crucial to evaluate our counterfactual argument. As detailed bellow, if one considers announcements dates and planned duration of each asset purchase programs, there are four quantitative easing rounds during this period. [6]

The macroeconomic and financial data from Brazil during each of these episodes are suggestive of possible effects. Taking the annualized averages during the identified policy rounds, inflation increases by 5.3%, activity grows 5.3%, consumption 7.9%, policy rate is reduced by 2.5 percentage points (p.p.), nominal exchange rate appreciates 7.3%, 9.3% in real terms, gross capital inflows grows 13.9% relative to the stock of net external

[5] In the banking sector the impact of this policy change may include a decline at the long-term end of the yield curve; a rising real estate (or, more generally, asset) prices and increased lending. It is supposed that these capital flows would go into several countries, including Brazil, which may be mostly transmitted through "excessive" capital inflows that can lead again to exchange rate appreciation,

[6] See section 4.2 for further details. For the sake of precision: QE1, from 2008m12 to 2009m06; QE1 extension, from 2009m07 to 2010m04; QE2, from 2010m08 to 2011m08; Operation Twist, from 2011m09 to 2012m06.

liabilities, gross portfolio inflows grows 17.6% relative to the stock of net external portfolio liabilities, total credit grows 0.9 p.p. of gross domestic product, stock market capitalization grows 4.4 p.p. of gross domestic product. However suggestive, these figures are meaningless without a reference point, such as the long run average or what was expected before the policies, or, as this paper investigates, what would have happened without the spillovers from quantitative easing policies.

From another perspective, we may also compare the initial and final values of Brazilian macroeconomic indicators as in Table I bellow. It is clear the actual behavior of the economy is not uniform across QE episodes. Nonetheless, the counterfactual behavior could go in the same direction in all episodes, which is a more structural feature of the economy. These are exactly the features we investigate in this paper.

Table I. Selected variables during QE policy rounds
Initial and final values at each period

	QE1		QE1ext		QE2		Twist	
Variable	t_0	t_1	t_0	t_1	t_0	t_1	t_0	t_1
Headline inflation (yoy,%)	6.4	4.8	4.8	5.3	4.6	7.2	7.2	4.9
Activity index (yoy,%)	0.3	-4.4	-4.4	10.8	6.9	2.2	2.2	1.5
Capital inflow (12m, USDbn)	61	28	28	109	116	176	176	107
Policy rate (p.p)	13.6	9.5	9.5	8.7	10.3	12.4	12.4	8.4
Nominal exchange rate (BRL)	2.27	1.96	1.96	1.76	1.77	1.60	1.60	2.05
Non-earmarked credit (%GDP)	28.6	29.0	29.0	28.8	28.9	30.2	30.2	32.4
Non-earmarked credit; households (%GDP)	13.0	14.0	14.0	14.5	14.4	15.2	15.2	16.1
Credit private banks; households (%GDP)	10.4	10.9	10.9	11.1	11.0	11.5	11.5	11.7
Interest rate; reference loans (p.p.)	44.1	36.6	36.6	34.3	35.4	39.7	39.7	31.1
Interest rate; reference loans; firms (p.p)	31.4	27.4	27.4	26.3	28.7	30.9	30.9	23.8
Stock market value (%GDP)	35.2	44.6	44.6	51.3	50.0	43.2	43.2	41.9

Source: Central Bank of Brazil and authors calculations.

A major goal of quantitative easing policies is to drive down interest rates, i.e. lowering and maintaining at a low level the yields of long-term securities, especially Treasuries in the case of the Federal Reserve.[7] There is a growing literature estimating the effects of quantitative easing policies in the U.S. and U.K. where the yields of long-term

[7] Ben S. Bernanke "Monetary Policy since the Onset of the Crisis" speech at the Federal Reserve Bank of Kansas City Economic Symposium, Jackson Hole, Wyoming, August 31, 2012, "*Declining yields and rising asset prices ease overall financial conditions and stimulate economic activity through channels similar to those for conventional monetary policy. (...) Large-scale asset purchases can influence financial conditions and the broader economy through other channels as well. For instance, they can signal that the central bank intends to pursue a persistently more accommodative policy stance than previously thought, thereby lowering investors' expectations for the future path of the federal funds rate and putting additional downward pressure on long-term interest rates, particularly in real terms.*"

securities are at center stage of the analysis, with effects obtained relative to a counterfactual "no policy" scenario (Pesaran and Smith (2012), Baumeister and Benati (2010), Chen *et.al* (2012)). There are other approaches as well, notably, event studies research strategies and macro-model simulation approaches. For instance, the IMF has undertaken a set of studies (IMF (2012)) on the possible spillover effects of policies conducted by five major systemic economies (the US, the Euro Zone, Japan, China and the UK) in the post-crisis environment. The report, which is mostly based on Fund's global macro-model simulations, concludes that we have evidence of highly correlated asset prices, negative effects of financial shocks, and that "*the actions and inactions of systemic economies have far greater effects on the world than in normal times*."

Before we review this literature, we highlight the substantive and methodological contributions from the paper. The policy debate would probably benefit from the substantive estimates of counterfactual effects for a range of variables in the Brazilian economy. The assessment of capital flows as a transmission channel, in the specific case of quantitative easing, is also a central contribution. From a more methodological point of view, the paper makes important additions to the counterfactual effects literature. The novel decomposition method based on a multivariate model is of general interest, and could be applied to investigate many other problems. We developed two new asymptotic statistical tests for *ex-post* policy effectiveness, as well as finite sample refinements of the same tests. The tests explore more information and are potentially more powerful than those previously tests available in the literature. Finally, we propose relevant methodological guidelines, such as the analysis of a grid of counterfactuals to improve the robustness of the results.

Roadmap. The paper is structured as follows. In the following section we review the literature closely related to this paper. The third section introduces the conceptual framework and presents our methodology. The fourth section reports the results for the model estimation, policy counterfactuals, *ex ante* effects and statistical tests of *ex post* effectiveness. The last section summarizes and offers some concluding remarks.

2. Related Literature

First, we highlight representative papers in the counterfactual tradition. Pesaran and Smith (2012) assume a 100 basis points (bps) counterfactual increase in the UK term

spread bond market, which corresponds to previously estimated announcement effects. They estimate the effect on UK GDP growth using a single equation model for this variable in which the term spread is included as an exogenous variable. Baumeister and Benati (2010) assume a 50 bps counterfactual for the UK term spread and conduct a similar exercise, controlling for structural breaks in the data generating process. Chen *et.al* (2012) consider policy counterfactuals of up to 200 basis points increase in the U.S. term spread, and subtract the effect on macroeconomic variables at a global scale using an estimated global vector autoregression model (VAR). They find asymmetric effects across different Emerging Market Economies (EMEs). For instance, the effect of US QE in Latin America Countries (LAC) is less diverse but also much stronger than in the emerging Asia. In fact, the authors show that in their EME sample, Brazil and Hong Kong were the economies most affected by the US QE policies. In the case of Brazil they highlight the strong currency appreciation and the related fall in industrial production. However, they do not propose any systematic way to decompose the channels generating those effects. Also, industrial production performed very poorly in the aftermath of the crisis, which suggests using a broader indicator.

We build mostly on this literature. In particular, we use the term spread as the only observed direct transmission channel of quantitative easing policies. However, we depart somewhat from the literature by considering indirect global channels, such as asset prices, commodity prices and global trade.[8] The reason for focusing on the direct impact of the term spread is that we have more confidence in models that uses the term spread as an exogenous variable than, for example, in the ones with central bank balance sheet variables. Since the goal of these policies has often been stated as a qualitative goal for the term spread, the literature seems to have found an appropriate substitute for conducting counterfactual exercises. Of course, the critical point is pinning down exactly what would have happened to the term spread in the "absence of QE", i.i. in the "no policy" scenario (also, in our case, what would have happened to the indirect global transmission channels). The simple reversion of the announcement effects, as suggested by Pesaran and Smith (2012) seems to be too conservative; the larger effects considered by Chen *et.al.* (2012) could be on the other extreme and considered exaggerated. Our position is to search for robust results across the range of policy counterfactuals considered in the literature.

[8] See sections 4.2 for thorough discussions of these issues, along with references to the literature.

The literature exploring announcement day effects, which provides the reference point for counterfactual exercises, usually applies event study methods to estimate the effects on long term Treasury yields and other rates. In fact, there is a growing literature employing such methods to estimate the effect of quantitative easing policy on the long term treasury yield, and other interest rates (Gagnon *et.al.* (2011); D´Amico and King (2010); Krishnamurthy *et.al.* (2011); Bauer (2012); Willians (2011)). The results point to effects around 100 bps for QE1 and around 20 bps for QE2. It is important to have in mind that these are the accumulated effects for the announcement days only. The same event study methodology has been applied, with significant results, to investigate the announcement effects over global financial markets, such as foreign bonds and currency values (Neely, 2012). The main advantage of this literature is to use a robust identification strategy. The main drawback is the lack of economic structure that would allow dynamic forecasts and counterfactual scenarios, such as the one we consider here.

An important aspect we investigate is the relationship between QE and capital flows, which we are formally assess by the estimated relative importance of capital flows as a transmission channel of estimated QE effects. The debate has been intense on whether the conjunction of both higher yield differential between advanced and emerging economies (due to "conventional" monetary policy) and liquidity provision to the balance sheets of banks (due to "unconventional" QE) have contributed to a "search for yield" – including through carry trade – and therefore increasing significantly in intensity and volume the flows of capital into emerging economies. Indeed, recently after the global financial crisis, a number of comprehensive reports and papers focused on the recent trends of capital inflows into emerging markets and its implications for policies aiming at off-setting the "destabilizing" consequences of large inflows to macroeconomic and financial stability. Among others, the examples are the BIS paper 44 (2008), the CGFS Paper 33 (BIS-CGFS (2009)), the IDB report March 2012, among others. Overall, the post-crisis literature has been revisiting the issue with a more balanced view regarding potentially destabilizing effect of large capital movements that were previously acknowledged. Naturally, the post-crisis literature on policy responses also evolved and is now giving more relevance to the usage of regulatory prudential tools – including capital controls – to manage capital inflows (Ostry et al., (2010, 2011); Barroso (2012)), possibly with interactions with monetary policy (Agénor et. al. (2012); Unsal (2013)).

3. Conceptual Framework

3.1. Policy Effect: Definition, Estimation and Testing

This paper builds on the conceptual framework proposed by Pesaran and Smith (2012) summarized in this section. The concepts will be extended in the following section.

Definition

We adopt the definition of a "policy effect" proposed by Pesaran and Smith (2012). Their definition applies to time series models and considers the policy effect relative to the counterfactual of a "no policy" scenario. Let the information set up to period t be $\Omega_t = \{y_{t-j}, z_{t-j}, w_{t-j}, x_{t-j}\}_{j=0\ldots\infty}$ where y_t and z_t are the endogenous variables, w_t are exogenous variables and x_t is the policy variable. Let the policy variable future trajectory be $\Psi_{\mathrm{t+h}}^{\mathrm{p}} = \{x_{t+j}^{p}\}_{j=1..h}$ where p is either the actual or the counterfactual policy. The *ex ante* policy effect $\hat{d}_{t+h}^{ex\ ante}$ on the outcome variable y_t, also referred to as planned or intended effect, is defined as follows:

$$d_{t+h}^{ex\ ante} = E\left(y_{t+h}|\Omega_t, \Psi_{\mathrm{t+h}}^{\mathrm{actual}}\right) - E\left(y_{t+h}|\Omega_t, \Psi_{\mathrm{t+h}}^{\mathrm{counterfactual}}\right), \quad (1)$$

where *E* is the expectation functional. The *ex post* effect is defined as

$$d_{t+h}^{ex\ post} = y_{t+h} - E\left(y_{t+h}|\Omega_t, \Psi_{\mathrm{t+h}}^{\mathrm{counterfactual}}\right), \quad (2)$$

or, equivalently

$$d_{t+h}^{ex\ post} = d_{t+h}^{ex\ ante} + \left(y_{t+h} - E\left(y_{t+h}|\Omega_t, \Psi_{\mathrm{t+h}}^{\mathrm{actual}}\right)\right) \quad (3)$$

Note that, in expression (3), the second term is the forecast error from the *ex ante* exercise.

Estimation with ARDL

The authors propose a simple procedure to obtain estimators for policy effects $\hat{d}_{t+h}^{ex\ ante}$ and $\hat{d}_{t+h}^{ex\ post}$. First, they observe that, in the absence of errors, the effect should be the same regardless of the transmission channels and intervening endogenous variables. Therefore, a parsimonious econometric model describing the dynamics of the outcome

variable excluding all other endogenous variables is all it is needed for estimating the policy effects. They therefore suggest a parsimonious autoregressive distributed lag (ARDL) specification, from which forecasts could be deduced by recursive application of the conditional model. The resulting forecasts represent estimates of the conditional expectations in (1)-(3) evaluated at the relevant information sets. Therefore, estimating the policy effect is straightforward.

Parameter Stability

The definitions accommodate parameter change when the actual or counterfactual policy involves regime change, as long as the conditional expectations refer to the data generating process. However, with an estimated model, a problem of parameter instability may arise due to regime change conditional on the counterfactual or the actual scenarios. This is possibly the main criticism of the estimation procedure. To cope with this issue, in the specific case of quantitative easing, we may assume that authorities implement unsystematic policy shocks instead of changing deep behavioral rules. In such case it is theoretically reasonable to admit parameter stability across policy counterfactual scenarios. This was indeed the assumption of Pesaran and Smith (2012) for the BoE quantitative easing policies, and will be our baseline assumption the Federal Reserve behavior.[9]

Testing for ex-post effect

Now consider testing if the average *ex post* effect is zero. Given a consistent estimator of the model, and supposing it is stationary, forecast errors in (3) will tend to cancel each other out. Therefore, Pesaran and Smith (2012) propose the following test statistic

$$p_H = \frac{1}{\sqrt{\hat{\sigma}^2}} \frac{1}{H} \sum_{h=1}^{H} \hat{d}_{t+h}^{ex\ ante} \sim N(0,1) \tag{4}$$

where $\hat{\sigma}^2$ is an estimator of the long run variance of the forecast errors, and H is the policy horizon. The test has a low power if: (i) the policy horizon is too short relative to the sample, (ii) the policy effects are very short lived or (iii) the model forecasts very poorly. For this alleged reason, the authors did not apply the test in their study of the U.K. In the next section we propose two additional tests that may overcome the power problems identified in the original test.

[9] We also performed a robustness exercise using only the crisis sample as you can see bellow.

3.2. Policy Effect: Further Concepts

We extend Pesaran and Smith (2012) in four directions. First, we propose estimating the policy effects from the forecasts of a structural vector autoregression. Second, we use the structure of the vector autoregression to investigate the transmission channels of the estimated policy effects. Third, we use the vector autoregression to extend the policy counterfactuals to other global transmission channels. Finally, we propose new tests of *ex post* policy effects taking advantage of the availability of multiple policy rounds in our sample period.

3.2.1. Estimation with VAR

We consider a parsimonious vector autoregressive model for the set of endogenous variables. The forecasts from the model will be used to estimate the policy effects. The focus here is on conceptual issues; the specific set of variables and other model selection issues will be presented in section 4. The main reason to propose a multivariate model is to represent different channels of transmission of the policy effect. In contrast, the autoregressive distributed lag model proposed by Pesaran and Smith (2012) does not include endogenous variables other than the target variable for the policy effect. The greater flexibility comes at a cost: the forecasts from a VAR would miss contemporaneous effect of the policy variables. We have two strategies to overcome this problem. First, we use a monthly data set, so as to avoid lagging too far behind the effects. Second, we will actually forecast from the recursive structural representation so as to capture the most of simultaneous effects. We inspect the pattern of impulse-response functions under the chosen recursive structure to avoid any counterintuitive behavior.

Consider the following VAR model:

$$y_t = A(L)y_{t-1} + a + \varepsilon_t \tag{5}$$

where $\varepsilon_t \sim iid(0, \Omega)$. Using the triangular factorization, $\Omega = \mathrm{B}^{-1}\Lambda\mathrm{B}^{-1'}$, with B a lower triangular matrix and Λ diagonal positive definite, we obtain the structural representation

$$By_t = BA(L)y_{t-1} + Ba + u_t \tag{6}$$

with $u_t \sim iid(0, \Lambda)$. If we had contemporaneous information on some of the variables ordered first in the vector y_t, such as actual or counterfactual policies, we could use the recursive structure in (6) to cascade this information into the forecasts of the other variables. In the result section bellow, we use the recursive structure in this manner to incorporate contemporaneous effects into our forecasts.

Since the policy effect estimation is to be performed on several outcome variables (much more than could be represented in the typical vector autoregression) it is important to have a set of core endogenous variables so as to impose some uniformity in the identification exercise. The uniformity argument has been used in investigations of responses of a large set of variables to a structural shock (Kim (2001); Jansen (2003)). Those papers estimate a core structural VAR model and then extend it one variable at a time when studying impulse responses (in our case, policy effects) of additional variables. We follow the exact same strategy when investigating variables outside the core model (we refer to section 4 for the selected core variables). For instance, if y_t is the core variable vector and $y_t^{'}$ the additional variable of interest, we model the vector $y_t^* = \{y_t, y_t^{'}\}$ with the ordering of $y_t^{'}$ defined as in Jansen (2003). We model y_t^* in the same say as in (5)-(6). The coefficients and the error process will not be the same as in the model with only the core variables. So, the simplicity of the procedure is not without its costs.

3.2.2. Transmission Channel Decomposition

We propose a decomposition of the overall effect into different transmission channels. The starting point is the many steps ahead forecasting from the vector autoregressive model (or it structural counterpart). We define this procedure and then generalize it.

Since the policy variables x_t work as inputs to the procedure, either as actual x_t^a or counterfactual values x_t^c, we will not use their equations in the forecasting exercise. Accordingly, let $z_t = \left(z_{1,t}, .., z_{n,t}\right)$ denote the vector of remaining variables in the vector autoregression. The h steps ahead forecast from the VAR model is defined recursively by:

$$\begin{gathered} F^p z_{i,t+d} = A^i(L)\left(F^p z_{t+d-1}, x_{t+d-1}^{p_i}\right) \\ i = 1..n, \\ d = 1, .., \mathrm{h} \\ F^p z_t = z_t \end{gathered} \tag{7}$$

where $A^i(L)$ is the line *i* of the coefficient matrix A(L), and where $p \epsilon \prod_n \{a, c\}$ is a n-vector indicating the policy input for each equation. The vector of *ex ante* effects is just

$$\boldsymbol{d}_{t+h}^{ex\ ante} = F^a z_{t+h} - F^c z_{t+h}, \tag{8}$$

We show in the appendix that the total *ex ante* effect can be decomposed as the sum of *marginal channel effect*s, in the following sense

$$\boldsymbol{d}_{t+h}^{ex\ ante} = \sum_{i=1..n} \left(F^a z_{t+h} - F^{(a_{-i}, c_i)} z_{t+h} \right) = \sum_{i=1..n} \boldsymbol{d}_{t+h}^{channel(i)} \tag{9}$$

In this expression, we take (a_{-i}, c_i) to denote the actual policy in all equations except for equation i, which will use the counterfactual policy. We take the *marginal channel effects* of variable $z_{i,t}$ on each endogenous variable as our measure of the quantitative significance of the *transmission channel* associated with variable $z_{i,t}$ for the effects on other variables. Analogous definitions apply to the forecasts from the structural representation, although the list *i=1… n* in (7) would have to be interpreted as the actual order of calculation, and the simultaneous coefficients would have to be included in the right hand side.

3.2.3. Policy Counterfactual for Quantitative Easing

In the case of quantitative easing, the counterfactual effect literature has moved to a soft kind of *petition principii,* where balance sheets are supposed to influence some variable for which we have a good historical track record in being capable of building sound time series models. In practice this variable is taken as the policy instrument, much like the interest rate would be the policy instrument for the monetary authority. The rationale for this strategy is simple: it is unlikely one could succeed in building a robust time series model based on central bank balance sheet variables, not only because of the inherent instability of monetary models, but also because balance sheets changed dramatically after the crisis, both quantitative and qualitatively.[10]

The term spread between ten year and short term government bonds has been the variable of choice in the literature, with counterfactual levels calibrated with reference to event studies.[11] Since the goal of quantitative easing policies has often been stated as a

[10] Panel models might overcome this, see Fratzscher, Lo Duca and Straub (2012).
[11] See section 4.2 for references to the literature.

qualitative goal for the term spread, this seems a natural choice. Nevertheless, a possible problem with this method is that quantitative easing is often thought to work through multiple global channels, like risk aversion, commodity prices or asset prices. It is unlikely that the historical effect of the term spread on these channels would capture the direct, first order effect of quantitative easing policies.

Our solution to this problem is to take a very careful additional step in the *petition principii* argument. For international transmission channels other than the term spread, we propose a two step procedure. First, we obtain the *ex ante* effect from the term spread only scenario on the global variables of interest. Second, subtract the estimated effect from the actual realization of the global variable to get their counterfactual levels. That is, let x_k denote the global variable and $x_{termspread}$ the term spread variable; we consider:

$$x_{k,t+h}^{counterfactual} = x_{k,t+h}^{actual} - d_{k,t+h}^{ex\ ante}\left(\{x_{termspread,t+j}^{counterfactual}\}_{j=1..h}\right) \quad (10)$$

Using the actual value as the baseline implies giving an implicit large weight to the idea that international variables responded mostly to shocks other than quantitative easing. Therefore, we are making it harder to find effects on domestic variables, that is, making it harder to corroborate the hypothesis we are investigating – a sound methodological principle. On the other hand, we may be introducing some bias for those policy effects for which some global transmission channel is particularly important.

Proceeding accordingly, we build a multidimensional policy counterfactual encompassing relevant international indicators from which the overall policy effect on domestic variables can be assessed. To the extent that international counterfactuals are sensible, and that a well specified econometric model for the relevant international variables is feasible, the procedure will result in less noisy estimates of *ex post* policy effects. In principle, this will contribute to a more powerful test for policy effects.

3.2.4. Testing with Multiple Policy Rounds

The Federal Reserve has promoted more than one round of quantitative easing[12]. We propose two natural extensions of the testing framework proposed by Pesaran and Smith (2012) to take advantage of the many rounds of policy events. The first one is a test for the pooled average *ex post* effect, which has the following asymptotic distribution

[12] See section 4.2 for the exact dating adopted in this paper.

$$t_{pool} = \left(\overline{\hat{\sigma}^2}\right)^{-1/2} \frac{1}{R} \sum_{i=1}^{R} \frac{1}{H_i} \sum_{h=1}^{H_i} \hat{d}_{t_i+h}^{ex\ ante} \sim N(0,1), \tag{11}$$

where $\overline{\hat{\sigma}^2}$ is the average of the estimated variance of forecast errors, and R is the number of policy rounds. The second one is a test for the joint hypothesis that average *ex post* effect was zero in each policy round (against the alternative hypothesis that some round had non zero average effect):

$$t_{each} = \sum_{i=1}^{R} \frac{1}{\hat{\sigma}_i^2} \left(\frac{1}{H_i} \sum_{h=1}^{H_i} \hat{d}_{t_i+h}^{ex\ ante} \right)^2 \sim \chi^2_{(R)}, \tag{12}$$

Both tests allow us to explore information from different rounds and therefore should be more powerful. A very important *caveat* here is that each policy round included in this study covers a short time span, of six to twelve months, approximately. Then the asymptotic approximation implicit in the testing procedure may be very poor. One possible solution is devising a bootstrap procedure to approximate the finite sample. Another solution is to think of successive policy rounds as being overlapped, so that effects from the first rounds would still be manifested in the actual realizations of the future rounds. The counterfactual and actual (nested within the first counterfactual) for overlapped periods might be inherited from the counterfactual that would prevail in the future, so that ex-ante effects from the first policy rounds eventually die out by design. For long run effects, such as financial stability, this may be important. But before such strategies be implemented in future studies, it is worth to look at the simpler approach considered here.

3.2.5. Bootstrap Testing

Whenever asymptotic distributions are not available for testing significance of particular effects or transmission channels, or when such tests are available but are possibly unreliable in finite samples, we apply a bootstrap procedure. The procedure consists of sampling with replacement from the domestic variables vector autoregression residuals at the parameters point estimates and re-estimating the model. All the estimates in this paper (ex-ante effects, ex post effects and channel decompositions) are pivotal or pivotal after standardization. Therefore, inference can proceed with the bootstrap analogues.

4. Results

The first step to estimate policy effects and their decomposition into transmission channels is implement a vector autoregression model for the variables of interest. The results from model selection and estimation are presented in section 4.1. We also need to build the policy counterfactuals for quantitative easing policies according to the conceptual framework from the previous section. We searched a grid of counterfactuals, and results are presented in section 4.2. Once we have the counterfactuals and the forecasting model, we may obtain policy effects, decompositions and test for the statistical significance of these quantities.

4.1. Vector Autoregression Model

Variables

The core model is intended to capture the main macroeconomic reduced form relations at work during quantitative easing episodes. For example, the capital flow equation should capture the influence of pull and push factors, which are transmitted to the other variables. Variable selection also considers these relations.

The variables selected to represent global transmission channels of quantitative easing, and, therefore, to build counterfactuals, were (i) *PriceRaw,* the international price index of raw materials relative the price of manufacturing goods; (ii) *Trade,* the international trade volume index; (iii) *TermSpd,* the spread between 10 year and 3 months Treasury yields; and (iv) *EmbiSpd,* the Embi+ spread of emerging market bonds.[13]

The variables selected to represent domestic transmission channels, and therefore to enter into channel decomposition estimates, where: (i) *IPCA,* the official headline price index for Brazil; (ii) *IBCbr*, an activity indicator for the Brazilian economy; (iii) *Inflow,* the accumulated gross capital inflow into Brazil, accumulated every month from the net external liabilities from January 1995, and measured in dollars; (iv) *Selic,* the Central Bank of Brazil policy rate; and (v) *Forex,* the nominal exchange rate (USD against the BRL). The accumulated capital inflows include foreign direct investment, portfolio and credit flows;

[13] The sources for price and volume series are from CPB Netherlands; the term spread is from the Federal Reserve, and the emerging market spread is from JP Morgan.

and *gross* means that only nonresident flows are considered. The Central Bank of Brazil was the source of all the core domestic variables, except for the headline inflation.[14]

In order to map these variables into the formal vector autoregression model defined in Section 3.2, and the associated forecasting and decomposition procedures, we make the following correspondence:

$$\begin{aligned} x_t &= (PriceRaw_t, Trade_t, TermSpd_t, EmbiSpd_t) \\ z_t &= (IPCA_t, IBCbr_t, Inflow_t, Selic_t, Forex_t) \\ y_t &= (x_t, z_t) \end{aligned} \tag{13}$$

The ordering of the variables is important. Variables ordered first are not to be affected by the next variables contemporaneously. The impulse response pattern is robust across different orderings assumptions. The ordering proposed here is fairly standard in the VAR literature.[15] These variables are non stationary or are indistinguishable from non stationary variables in our sample size. We measure all the variables in logarithms or in percentage points. Therefore, the policy effects should be interpreted as percentage changes (or point changes) of actual levels relative to counterfactual levels.

Full Sample

The full sample for our exercise consists of time series of monthly indicators from January, 2000 to June, 2012, or 150 time periods. We also consider a crisis sample bellow.

Model Specification

The model was estimated in levels to capture possible long run relations between the variables. Although there was evidence of at least two cointegration relations in our core vector, we choose not to impose possibly false restrictions and identifying assumptions. We note that, as a result of these possible relations, the model in differences would not be able to capture the dynamics of the system in a parsimonious and consistent specification. However, the levels model captured rich dynamics with as few as two lags – the lag length selected by all information criteria. The recursive structural model was estimated by full information maximum likelihood, which amounts to Cholesky decomposition in the present context. The model seems well specified. There is no evidence of residual autocorrelation or heteroscedasticity, but normality nulls were rejected. Parameter instability was not detected by fluctuation tests, although those tests can

[14] IPCA is calculated by the IBGE, the Brazilian national statistical agency.
[15] See Jansen (2003) for an example of similar ordering.

overlook some changes in the response pattern of the economy. Also, formal break tests suggest breaks around the beginning of quantitative easing.

Crisis sample

As a robustness check, we also estimated the model for the restricted sample beginning a couple of years before quantitative easing policies. We also tried to restrict the sample to the period subsequent the first round of quantitative easing; but that model performed poorly, possibly a small sample problem. In any case, a structural model would suggest that unconventional policies were one among possible policy options and therefore to some degree as a possible state of the world once the crisis begun. So, we should include some data prior do quantitative easing, although it is not clear how far we should go.

With that in mind, we set the beginning of the subsample to January 2006, about two years before the peak of the NBER cycle before the great recession cycle, and so including the boom years just before the fall. We will refer to this subsample as the "crisis sample", which considers a couple of years before the crisis in order to capture possible structural forward looking behavior and ends in June 2012. The model estimated in this subsample seems to be sufficiently well specified, although forecasts are relatively more responsive to the scenarios. Apart from parameter uncertainty, results for the subsample could be sharper than for the full sample.

Additional Variables

The core variables in the model capture the main macroeconomic relations. We are also interested in the finer detail of the policy impact and of the transmission channels. Therefore, from a set of additional variables, we include one variable at a time in the core model to analyze additional effects and channels of interest. As mentioned in the methodology section, this is a common procedure to investigate a large set of variables in a uniform structural context (Kim, 2001; Jansen, 2003). Whenever the direction of the effect on the full and crisis sample diverged, we took it as a sign of model instability and excluded the variable from the analysis. The result was the exclusion of 14 out of 60 variables. The appendix presents a variable list and further details.

4.2. Policy Counterfactuals

Dating Policy Rounds

By mid 2012 the Federal Reserve had promoted three rounds of quantitative easing. Again, we capture direct policy effects only through its impact on the term spread between 10 year and 3 months treasury yields. Therefore, we also include Operation Twist in our list of "quantitative easing" policy rounds.[16]

Considering the most common dating of these events, we may estipulate the following policy windows: QE1, from 2008m12 to 2009m06; QE1 extension, from 2009m07 to 2010m04; QE2, from 2010m08 to 2011m08; Operation Twist, from 2011m09 to 2012m06. The first two windows are in agreement to Chen *et.al* (2012). The last two windows follow from the announcement dates and the announced planned duration.

Calibrating the Term Spread Counterfactual

As briefly mentioned, there is a growing literature employing event study methods to estimate the effect of quantitative easing policy on the long term treasury yield, and other interest rates (Gagnon, et al, 2011; D´Amico and King, 2010; Krishnamurthy, et al, 2011). Other papers survey the literature from a policy perspective (Bauer, 2012; Willians, 2011). The results point to an effect around 100 bps for QE1 and around 20 bps for QE2. These are the accumulated effects from announcement days. When one considers what would have happened without the policies, it may be too conservative just to reverse the announcement effects. As argued by many, there could have been potentially a very severe deterioration in market conditions had the policies not been implemented. Such a possible deterioration was clearly in the minds of policy makers and may also be the main motivation for them to pursue this strategy. A somewhat restricted way to capture this potential events and policy motivations is to use counterfactual policies in levels that more than reverse announcement effects estimated in the literature. Chen *et.al* (2012) proposed policy counterfactuals with relatively larger effects on the term spread, up to 200 basis points, much larger than the reversal of the announcement effects estimated by the literature. As a reference, the baseline scenario of the IMF 2012 spillover report for a sudden run on long term treasury securities is 200 bps.

[16] Indeed, Hamilton and Wu (2012) shows maturity swaps are equivalent to adequately sized purchases of long-term maturities outright with newly created reserves.

Grid Specification

Instead of taking a stand on what would be the most reasonable counterfactual, we have searched for robust results across a range of alternatives. Following the literature we assumed that policy effects lie under a grid of counterfactuals ranging from 75 bps to 225 bps increase in the term spread. For reporting purposes, the channel decomposition results will be reported only for the 150 bps scenario, though the general pattern of the decomposition was robust across the grid of scenarios.

Other International Channels

Quantitative easing may be transmitted to other countries through the bond, commodity and financial markets, as well as through the real economy. The literature explored the bond and currency markets using the same event methodology as afore mentioned, and results are also significant (Neely (2012)). However, other international channels have not been thoroughly studied. We consider, therefore, the evidence prior to the crisis. Kim (2001) found that expansionary monetary policy shocks lead to booms in other major economies. Along those lines, it seems quite obvious that avoiding a severe contraction of output in the US would avoid demand collapses elsewhere, with a potentially positive effect on commodity and other asset prices. Anzuini, Lombardi and Pagano (2006) identified a direct impact of monetary policy on commodity prices, although its size was modest. Bastourre *et.al.* (2012) document that global liquidity is a common determinant driving commodity prices and emerging market spreads, particularly for commodity exporting countries.

Although the literature would suggest the existence of some effects, there is no guidance for the exact impact of QE on international transmission channels. Therefore, we adopt the somewhat *ad hoc* procedure described in Section 3.2.3. That is, first, we estimate the *ex ante* effect, and then we subtract it from the actual outcome for the international variables to get their counterfactual levels. From a methodological point of view, we are "shrinking" the estimates toward the actual realization of the variables, which represent the no effect scenario. Figure 1 summarizes the results of these procedures for the grid of counterfactual increases of 75, 125 and 225 basis points in the term spread.

The difference between the actual levels (gray lines) and counterfactual levels (blue lines) gives the magnitude of the policy shock. The corresponding accumulated effect on commodity prices (average across rounds) is a counterfactual increase of 2.5%, 5.2% or 7.9%, that is, the actual level is higher than the counterfactual by these much percentages.

Similarly, for world trade volume, there was an increase of 1.3%, 2.7% and 4.1%; for the Embi+ Spread, a decrease of 16 bps, 38 bps and 61 bps. In a nutshell, the effect of QE was indeed to produce a mild commodity price boom and to reduce sovereign risk. Yet, it is important to remember we are purposefully shrinking the estimates toward low effects.

4.3. *Ex ante* policy effects

The results for *ex ante* policy effects are summarized in Table 1 and Table 2, which report point estimates. The first table refers to the full sample estimates, and is appropriate if quantitative easing is considered to be a non systematic shock. The second refers to the crisis sample estimates, which are more appropriate if the policy regime has changed with the onset of the crisis. The sign patter is the same in the core variables highlighted in the first five rows of the tables. It is also the same for the additional variables. The shading pattern of both tables summarizes information on the statistical significance of the point estimates; dark shading means significant at 5%, medium shading at 10% and light gray at 15%. The p-values were calculated by the bootstrap procedure described in section 3.2.5.

Since the variables are either in logs (or in percentage points), the policy effects represent percentage changes (point changes) of the actual level relative to the counterfactual level.[17]

In the full sample, as reported in Table 1, each policy round of quantitative easing was expected to lead to an increase in accumulated gross capital inflows (from 1.8% to 5.4% depending on the counterfactual scenario), an appreciation of the nominal exchange rate (from 3.3% to 10.1%), an increase in economic activity (from 0.4% to 1.3%), a reduction in the policy rate (from 50 bps to 130 bps) and a decrease in the price level measured by the IPCA (from 0.3% to 1%). These are the *ex ante* policy effects defined before. Factoring in estimator uncertainty, **only the *ex-ante* effects for the exchange rate, capital inflows and activity were significant**. The point estimates for the crisis sample, as reported in Table 2, were generally larger in absolute value than the results for the full sample, with effects doubling for activity, inflow and policy rate, and rising 1 p.p. for the nominal exchange rate, but were smaller for the price level; all the effects were significant, except for the price level. Estimates had a strongly statistically significant in the crisis sample. Figure 2 allows a visual comparison of the policy effects in the full sample

[17] See definition of policy effects in Section 3.1 and definition of the variables in Section 4.1.

and the crisis sample, as well as an evaluation of the forecast accuracy of the model conditional on actual policies.

The price index and policy rate reduction deserve further comments. First, interpret the anticipated reduction in policy rate as a result quantitative easing. Fundamentally, it reflects the influence of the foreign interest rate on Brazil's domestic policy setting; that is, domestic interest rate tend to be lower when international rates, capture by the term spread and Embi+ spread, are lower. Now, interpret the foreseeable reduction in the headline price index as a result of the same QE policy. This effect is mostly reflecting the strong currency appreciation, which is the most important transmission channel for prices (we corroborate this assertion in the next section, which reports channel decompositions). However it also reflects the shrinking towards zero of the global activity effect, which was a methodological device to focus on results driven by the term spread (which can be associated with quantitative easing without controversy). We explore in section 4.3.1 bellow how much stronger our priors on global activity should be in order to reverse the sign of the inflation effect. In any case, what is important to notice at this point is that the price index effect was not statistically significant in any of the samples.

The estimates for the credit variables indicate quantitative easing stimulated Brazilian non earmarked credit (from 0.2 p.p. of GDP to 0.6 p.p. of GDP on each policy round) with the bulk of the effect coming from the household sector, and mostly from private banks. The larger effects from an economic point of view are also the most statistically significant. Estimates of the credit effect for the crisis sample are larger (from 0.4 p.p. of GDP to 1.0 p.p. GDP), and the pattern for households and private banks is the same. The effect on credit quality is positive meaning that, as far as the short horizon of six to twelve months is considered, financial stability has not been affected, that is, credit at risk decreases as a share of total credit (from 0.1 p.p. to 0.2 p.p, or nine times that for the crisis sample), reflecting the improvement in the economic environment. However, it is important to notice that considering a larger horizons there would likely be some deterioration in credit risk as a consequence of the credit cycle (impulse-response functions for these credit risk variables to structural capital inflow shocks are consistent with this view and timing). **In any case, only credit quality of manufacturing firms was significant,** after accounting for estimation uncertainty**.** Regarding credit prices, interest rates would be higher without quantitative easing, as reflected in the negative effects (from -1.0 p.p to -3.0 p.p, or two times this for the crisis sample).

The two measures of stock market we consider are the total market value of listed corporations and the size of the stock market mutual funds industry, both measured as a share of gross domestic product. Without quantitative easing Brazil might not have experienced the stock market rally that actually happened, and its fund industry would have grown less. This amounts to positive effects for stock market (from 3.2 to 10.0 p.p. of GDP, depending on the counterfactual scenario), and on the mutual funds industry (0.4 to 1.3 p.p. of GDP), considering the full sample estimates. Effects estimated for the crisis sample are about 4.0 p.p. of GDP larger for the stock market across scenarios, and about 0.3 p.p. of GDP larger for stock market funds.

Point estimates for the disaggregated price indexes concur with the headline consumer price index, although the same caveats presented before still apply (that is, strong appreciation and muted commodity boom). Producer prices show the larger impact (from 1.8% to 5.3% reduction), followed by food prices (from 0.8% to 2.3% reduction), with the effects a bit smaller when we estimate the model using only the crises sample.

Considering the external sector variables, the full sample effects of accumulated gross inflows disaggregated into foreign direct investment (from 0.7% to 2.1%), portfolio (from 2.8% to 8.6%) and total credit (from 4% to 12%) are consistent with the large effect for aggregate capital inflow. Moving to the crisis sample, estimated effects remain the same for foreign direct investment, double for portfolio flows, and tree times for credit flows. Trade flows are also positively impacted by quantitative easing on each round, with effects for import volume (from 2.9% to 8.1%) larger than export volume (from .5% to .9%) in the full sample estimates, and roughly the opposite values for the crisis sample estimates. **The stock of international reserves would be smaller in the counterfactual no policy scenarios, with effects around 1 p.p. of GDP or 0.5 p.p. of M2 at each policy round, with some small variation depending on the scenario.** These results possibly reflect the intervention policy regime, which began to put in place a framework to lean against the wind of capital inflows associated with global liquidity (Barroso and Sales, 2012).

Domestic economic activity would generally be lower without quantitative easing policies, resulting in positive *ex ante*, foreseeable effects. Retail sales (from 1.0% to 2.8%), auto sales (from 3.3% to 10.0%) and civil construction employment (from 0.5% to 1.5%) and input use (from 1.0% to 2.9%) stand out with large effect point estimates in the full sample, which double in the crisis sample for retail and auto sales. Industrial production (from 0.1% to 0.2%; or 1.2% to 3.7% in the crisis sample), fixed

capital absortion (from 0.3% to 1.5%; or 1.3% to 4.1%) and installed capacity utilization (from 0.2 p.p to 0.7 p.p., or 0.5 p.p to 1.5 p.p) also had positive effects from quantitative easing.

4.3.1. Different priors on global transmission channels

As a methodological guideline, we imposed weak priors on global transmission channels, except for the term spread. The estimated effect of the term spread on the other channels is rather small. We subtracted these small effects from the baseline actual realizations of the variables to obtain the counterfactuals, as formally defined in equation (10) above. In this section, we impose stronger priors for the global channels in order to investigate how robust our results for inflation are under different scenarios. To this end, we multiply the term spread effect by a factor $\lambda>1$ before subtracting it from actual realization of the channels.[18]

It turns out world trade, a proxy for global activity and global price pressures, is the key international channel driving the inflation result.[19] Table 10 reports the outputs of the exercise for this channel. As we increase our priors regarding the importance of global activity, by increasing the λ multiplicative factor, the estimated inflation effect goes from negative to positive, although not statistically significant for any scenario. At the same time, the effect on capital inflows, the nominal exchange rate and the policy rate are smoothed and the estimates become increasingly uncertain.

4.3.2. Results for each policy round

In the previous sections we reported the average effect across policy rounds. From a policy perspective, it is also relevant to look at particular events and to present results in terms of more closely monitored variables (instead of percent changes as above). Therefore, we extend Table I from the introduction by including the counterfactual values and the *ex-ante* effects, considering a 150 bps counterfactual for the term spread.[20] The results are reported in Table II. The economic significance of the effects considered in the

[18] To be clear, for the k channel, $x_{k,t+h}^{counterfactual}(\boldsymbol{\lambda}) = x_{k,t+h}^{actual} - \boldsymbol{\lambda}\, d_{k,t+h}^{ex\ ante}\left(\{x_{termspread,t+j}^{counterfactual}\}_{j=1..h}\right)$.

[19] The other channels had countervailing effects on the exchange rate, for instance commodity price shocks lead to a simultaneous appreciation of the exchange rate, which reduces the impact on inflation.

[20] Results for other points in the grid of counterfactuals are available from the authors upon request.

previous sections appears clearly and are sizeable. The additional capital inflows resulting from QE2, for instance, are of the order of 100 USD billion, considering the crisis sample estimates. This was associated with additional 0.9% of GDP of non earmarked credit to households, a fall of 5 p.p. in interest rates in reference loans, an increase of 12% of GDP in the stock market value, a nominal exchange rate appreciation of 20 basis points, with a counterfactual exchange rate of 1.8 against the actual 1.6 BRL/USD.

4.4. *Ex ante* policy effects decomposition

The results for *ex ante* policy effects are summarized in Table 3 and Table 4, which consider only the counterfactual of 150 bps increase in the term spread.[21] It is worth to say that qualitative results are the same across the range of scenarios we consider. The shading pattern of both tables summarizes information on the statistical significance of the point estimates; dark shading means significant at 5%, medium shading at 10% and light gray at 15%. Significance tests were obtained from the bootstrap procedure described in the previous section.

The capital inflow channel explains 25% of the effects in the full sample and 60% of the effects in the crisis sample, considering the median share of the total effect explained by the channel across variables. If we consider only the core variables, the share explained by capital flows is 45% and 72% for the full sample and crisis sample respectively. The median is the appropriate summary statistic because some cases with a low denominator implied large, outlier shares for the channels. As evidenced by the shading patterns in the table, the capital inflow channel was the only one which was consistently significant across variables and samples. When the statistical significance is added to the economically significant share of the explained effects, **it is possible to say with a great degree of confidence that capital inflows were the most important transmission channel into Brazil of quantitative easing policies.**

The credit variables, including credit aggregates, credit risk and interest rates, show a particularly high contribution stemming from the capital inflow channel. Considering median shares, capital inflows account for 34% of the effects of credit variables (63% for the crisis sample). International variables effects share of effects

[21] Results for other ranges are available upon request to the authors.

explained by capital inflows is 25% (51% for the crisis sample), which is also a large share relative to other variables.

The results of the channel decomposition can also be displayed with graphs, with the advantage of exhibiting the full path of accumulated effects. Figure 3 and 4 show the time path of different channel contributions to the overall effects of core variables. There are qualitative differences in the channel decomposition of the full sample and the crisis sample. Although capital inflows represent an important channel in both cases, it appears to be more so for the crisis sample estimates. In particular, if we believe the crisis sample is more representative of possible changing in reduced form parameters, the exchange rate appreciation should be explained more by capital flows than otherwise. The negative effect on headline prices for the full sample is mostly explained by the negative pass-through effect resulting from the exchange rate appreciation; but the almost null effect for the crisis sample reflects the countervailing upward pressure from capital inflows. Larger capital inflows would explain lower interest rates than otherwise. In part, this reflects the appreciation pressures, which helps monetary policy. But it could also represent the desire to minimize further inflows and the associated asset price and credit market booms.[22]

4.5. Tests for *ex post* policy effect

We implemented two tests for ex post effects; the test for no pooled average effect, defined in (7), and the test for no average effect in each policy round, in (8). Both tests were performed for all the variables and considering the full and the crisis sample. Results are summarized in Tables 5 to 8, which cover the four possible cases. We use the same shading pattern for significance as before the p-values for the tests were obtained from the asymptotic distribution of the statistics. We also calculated finite sample corrections for the p-values based on the same bootstrap procedure as the previous sections.

The pooled-average test seems to have inherited the poor power properties of the original test proposed by Pesaran and Smith (2012). Effects were not significant in the full sample, except from some isolated variables under very extreme counterfactual scenarios. **Focusing on the crisis sample, the effects on capital inflow and on interest rates turn out to be significant. The same occurs with aggregate credit, mostly from private banks and directed at households, but also from foreign banks. The interest**

[22] The impulse-response functions of inflows to the policy rate shock are significantly negative.

Table II. Selected variables during QE policy rounds; actual values, coutnerfactual values and ex-ante effects (150 bps counterfactual termspread)

	QE1						QE1ext						QE2						Twist					
	actual		counterf.		effect		actual		counterf.		effect		actual		counterf.		effect		actual		counterf.		effect	
Variable	t_0	t_1	t_1^o	t_1^c	Δ_1^o	Δ_1^c	t_0	t_1	t_1^o	t_1^c	Δ^o	Δ^c	t_0	t_1	t_1^o	t_1^c	Δ^o	Δ^c	t_0	t_1	t_1^o	t_1^c	Δ^o	Δ^c
Headline inflation (yoy,%)	6.4	4.8	5.2	5.1	-0.41	-0.26	4.8	5.3	6.0	5.4	-0.73	-0.11	4.6	7.2	8.2	7.0	-0.94	0.18	7.2	4.9	5.7	5.2	-0.74	-0.27
Activity index (yoy,%)	0.3	-4.4	-4.8	-5.7	0.39	1.34	-4.4	10.8	9.9	8.5	0.91	2.3	6.9	2.2	0.9	-0.3	1.32	2.46	2.2	1.5	0.7	-0.1	0.86	1.65
Capital inflow (12m, USDbn)	61	28	11	-10	16.8	37.8	28	109	82	48.5	27.0	60.3	116	176	133	72.7	43.4	103	176	107	71	28.9	36.6	78.2
Policy rate (p.p)	13.6	9.5	10.0	11.2	-0.45	-1.71	9.5	8.7	9.7	11	-1.00	-2.26	10.3	12.4	13.7	15	-1.31	-2.56	12.4	8.4	9.3	10.5	-0.86	-2.11
Nominal exchange rate (BRL)	2.27	1.96	2.08	2.05	-0.13	-0.10	1.96	1.76	1.87	1.89	-0.12	-0.13	1.77	1.60	1.71	1.8	-0.11	-0.20	1.60	2.05	2.19	2.2	-0.15	-0.15
Non-earmarked credit (%gdp)	28.6	29.0	28.8	28.9	0.26	0.17	29.0	28.8	28.4	28.1	0.41	0.66	28.9	30.2	29.7	28.7	0.58	1.51	30.2	32.4	32.1	31.9	0.36	0.53
Non-earmarked credit; households (%gdp)	13.0	14.0	13.8	13.8	0.26	0.27	14.0	14.5	14.1	13.9	0.32	0.52	14.4	15.2	14.8	14.3	0.37	0.91	15.2	16.1	15.8	15.6	0.32	0.47
Credit private banks; households (%gdp)	10.4	10.9	10.7	10.7	0.25	0.25	10.9	11.1	10.8	10.6	0.33	0.49	11.0	11.5	11.1	10.7	0.39	0.80	11.5	11.7	11.4	11.3	0.31	0.43
Interest rate; reference loans (p.p.)	44.1	36.6	37.6	39.7	-0.95	-3.1	36.6	34.3	36.2	38.9	-1.94	-4.6	35.4	39.7	42.6	44.9	-2.92	-5.2	39.7	31.1	33.3	35.7	-2.16	-4.6
Interest rate; reference loans; firms	31.4	27.4	28.1	31.2	-0.67	-3.8	27.4	26.3	28.1	31.2	-1.79	-4.9	28.7	30.9	34.0	36.6	-3.08	-5.7	30.9	23.8	26.0	29.1	-2.24	-5.3
Stock market value (%gdp)	35.2	44.6	39.0	34.7	5.59	9.88	44.6	51.3	44.6	39.6	6.74	11.7	50.0	43.2	35.9	30.8	7.31	12.4	43.2	41.9	35.1	31	6.83	10.9

Source: Central Bank of Brazil and author's calculations

Columns:

t_0 actual value at the begining-period

t_1 actual value at the end-period

t_1^o counterfactual value at the end-period, full sample

t_1^c counterfactual value at the end-period, crisis sample

Δ_1^o ex ante effect, full sample, $t_1 - t_1^o$

Δ_1^c ex ante effect, crisis sample, $t_1 - t_1^c$

rate and credit risk effects were also significant. Both measures of stock market effects were significant. Finally, portfolio and credit capital inflows, as well as international reserves present significant ex-post effects.

The each-average test appears to have better power properties, at least for our case. **We do obtain significant *ex post* effects even with the full sample estimates, but usually this would require a counterfactual increase in the term spread of at least 150 bps. In particular, interest rates, capital flow, international variables and a few activity an price variables all presented significant effects.** The crisis sample estimates achieve even better results, with most of the variables rejecting the no effect null under reasonable counterfactuals scenarios. Since power was the major limitation of the available tests in the literature, we find the results with the chi-squared test proposed in this paper to be encouraging. The essential point is to pool information from many policy rounds during short enough windows to minimize uncertainty in the estimated effects.

5. Conclusion

The evidence in this paper is consistent with the view of emerging market policy makers. Quantitative easing policies have had strong spillover effects on the Brazilian economy. The foreseeable effects include "excessive" capital inflows, exchange rate appreciation, stock market price increases and a credit boom, with new credit mainly extended to households, which stimulated retail sales, auto sales and economic activity in general. These effects were not only foreseeable by our model, but also statistically significant in an *ex post* sense for at least some of the previous QE policy rounds, as demonstrated by formal econometric tests of such hypothesis.

Capital inflows were found to be the most important transmission channel of quantitative easing to other domestic variables. This conclusion follows both from the relative importance of the capital inflows in channel decompositions and from the fact that only the capital flow channel was consistently statistically significant across variables and samples. Since capital inflow is the main channel, there is possibly a case for capital inflow regulation, possibly from a macroprudential perspective and taking into account interactions with monetary policy (Agénor et al. (2012); Barroso (2012)). The effectiveness of regulation must be assessed, perhaps with the same methodology proposed here.

The evidence shows that quantitative easing policies to some degree did support domestic activity, including industrial production, capacity utilization, employment and civil

construction, as claimed by advanced economies' policy markers. However, since capital inflow is the main transmission channel of such policies, the share of the positive effects on activity not associated with collateral destabilizing consequences in credit and asset markets is relatively small.

The estimated monetary policy behavior suggests domestic interest rates were lower than they would otherwise be in the counterfactual with no quantitative easing scenarios. This result follows from the reduction in foreign interest rates, captured by the term spread and the risk spread to emerging markets. It also reflected the estimated disinflationary effect from quantitative easing. This last result is somewhat counterintuitive given the large credit and activity effects. In the context of our model and our assumption on counterfactuals, it followed from strong appreciation pressures and relatively strong global activity.

It should be noted that global activity counterfactuals have small effects by construction, in order to focus on the term spread as a transmission channel. In an exercise in which we suppose the policy maker would have stronger priors on the importance of quantitative easing on global activity, it was shown the counterfactual effect on inflation and interest rates would be positive. Although this result is important from a policy perspective, and may rationalize claims that quantitative easing could be inflationary under certain conditions, it does require stronger priors in more specific directions than we were willing to assume in the initial design of the research. Unless there was more evidence of global quantitative easing effects in the required direction, and this should be the object of further research, the evaluation of such claims, in the context of our methodology, would be mostly subjective.

Our conclusions are robust across a wide range of policy counterfactuals, regime break assumptions and testing procedures (except possibly for inflation). Given the uncertainty surrounding the first order direct effects of quantitative easing on the term spread and other international transmission mechanisms, it is important to have robust results on a large grid of counterfactuals. The possibility of regime changes upon the start of quantitative easing is not particularly supported by our model, suggesting the policy is mostly unsystematic in nature. In any case, our results are not only robust, but actually stronger for the subsample which control for possible parameter instability.

It is important to note we do not measure the effects on or the transmission channel through *countervailing policy measures* in the domestic and cross border credit markets. Brazil has implemented a series of macroprudential measures to address possible effects

from capital flows and credit growth, strengthening or relaxing the measures (Pereira and Harris (2012); Barroso and Sales (2012)). The conditional forecasts do not *explicitly* take into account possible systematic behavior of macroprudential policies. However, it is not the case that high (low) global liquidity forecasts overestimate inflows because they do not factor in expected macroprudential strengthening (weakening). What actually happens is that the dynamic forecast generated by our model already incorporate such effects, much like a parsimonious autoregressive lag specification ignoring some endogenous variables would factor in their effect on the estimated coefficients. What could be biased is the channel decomposition, as long as macroprudential policies affect disproportionally some of the variables. It is more appropriate to interpret the channel decompositions as *cum macroprudential reactions*. For example, we have not estimated the "pure" capital inflow channel, only the capital inflow channel taking into account any effect from countervailing policies acting through this channel. In this case, we could be underestimating the capital inflow channel, which reinforces our conclusions.

The novel methodology developed in this paper could be applied to other emerging market economies in order to verify the generality of the conclusions. The method may also be adapted to investigate other issues. In the context of quantitative easing, we could build counterfactuals spanning a larger time horizon, for example, so as to capture directly financial instability effects which take longer to build up. The effectiveness of capital flow regulation or other macroprudential measures, for another example, could be investigated with a more simplified counterfactual, for instance, some index of such regulations. Finally, the channel decomposition methodology is of general interest for any type of counterfactual exercise and should be a valuable tool for researchers in many fields.

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Table 1. *Ex ante* effect of quantitative easing for the full sample

Accumulated Ex Ante Effect Average across QE rounds (%, unless otherwise noticed)	**75**	100	125	**150**	175	200	**225**	150 Full Sample 2000m01 to 2012m06 pvalue
Price	-0,34	-0,45	-0,56	-0,67	-0,78	-0,89	-1,00	0,263
Activity	0,43	0,57	0,71	0,85	0,98	1,12	1,26	0,053
Inflow	1,79	2,38	2,98	3,58	4,18	4,78	5,37	0,007
Selic (p.p)	-0,46	-0,61	-0,76	-0,90	-1,05	-1,20	-1,35	0,157
Forex	-3,26	-4,41	-5,55	-6,69	-7,84	-8,98	-10,13	0,083
Non ear marked credit (%gdp)	0,21	0,27	0,34	0,41	0,47	0,54	0,61	0,037
Non ear marked credit; firms	0,06	0,08	0,10	0,11	0,13	0,15	0,16	0,240
Non ear marked credit; households	0,16	0,21	0,26	0,32	0,37	0,42	0,48	0,003
Credit from private banks	0,26	0,34	0,42	0,51	0,59	0,67	0,75	0,027
Credit from private banks; households	0,16	0,21	0,27	0,32	0,37	0,43	0,48	0,003
Credit from private banks; manufacture	0,04	0,06	0,07	0,08	0,09	0,11	0,12	0,193
Credit from private banks; retail	0,03	0,04	0,05	0,06	0,07	0,08	0,09	0,017
Credit from foreign banks	0,12	0,15	0,19	0,23	0,26	0,30	0,34	0,017
Credit from foreign banks; households	0,06	0,09	0,11	0,13	0,15	0,17	0,19	0,007
Credit from foreign banks; manufacture	0,02	0,03	0,04	0,05	0,05	0,06	0,07	0,390
Credit from foreign banks; retail	0,00	0,00	0,00	0,00	-0,01	-0,01	-0,01	0,440
Credit at risk; D or worse (%credit)	-0,06	-0,08	-0,09	-0,11	-0,13	-0,14	-0,16	0,270
Credit at risk; D or worse; households	-0,07	-0,10	-0,13	-0,15	-0,18	-0,21	-0,23	0,303
Credit at risk; D or worse; manufacture	-0,11	-0,14	-0,18	-0,22	-0,25	-0,29	-0,33	0,114
Credit at risk; D or worse; manuf+retail	-0,12	-0,16	-0,20	-0,24	-0,28	-0,31	-0,35	0,170
Interest rate; reference loans (p.p.)	-1,02	-1,34	-1,67	-1,99	-2,32	-2,65	-2,97	0,033
Interest rate; reference loans; households	-1,50	-2,02	-2,54	-3,06	-3,58	-4,10	-4,62	0,057
Interest rate; reference loans; firms	-1,01	-1,32	-1,63	-1,95	-2,26	-2,57	-2,89	0,007
Interest rate spread; reference loans	-0,59	-0,79	-0,99	-1,19	-1,39	-1,59	-1,79	0,017
Interest rate spread; reference loans; firms	-0,67	-0,90	-1,13	-1,35	-1,58	-1,81	-2,03	0,000
Stock market funds (%gdp)	0,44	0,59	0,74	0,89	1,04	1,19	1,34	0,000
Stock market value (%gdp)	3,23	4,36	5,49	6,62	7,74	8,87	10,00	0,007
Headline price index; services	-0,17	-0,23	-0,28	-0,34	-0,39	-0,45	-0,50	0,393
Headline price index; food	-0,75	-1,01	-1,27	-1,53	-1,79	-2,05	-2,32	0,173
Headline price index; core	-0,43	-0,57	-0,71	-0,85	-0,99	-1,13	-1,27	0,093
Producer price index	-1,80	-2,40	-3,01	-3,62	-4,22	-4,83	-5,43	0,083
Gross inflow; acm; direct investment	0,72	0,95	1,19	1,42	1,66	1,90	2,13	0,190
Gross inflow; acm; porfolio	2,84	3,81	4,77	5,73	6,69	7,65	8,62	0,023
Gross inflow; acm; credit	4,01	5,36	6,71	8,06	9,41	10,76	12,11	0,003
Export quantum	0,46	0,52	0,59	0,66	0,72	0,79	0,86	0,290
Import quantum	2,86	3,74	4,62	5,50	6,37	7,25	8,13	0,017
Import quantum; intermediate	2,64	3,43	4,22	5,00	5,79	6,58	7,37	0,013
International reserves (%gdp)	0,66	0,88	1,10	1,32	1,55	1,77	1,99	0,023
International reserves (%m2)	0,25	0,34	0,42	0,51	0,59	0,68	0,76	0,020
Unemployment rate (p.p)	0,00	0,01	0,01	0,02	0,03	0,03	0,04	0,367
Formal employment; retail and service	-0,01	-0,01	-0,01	-0,02	-0,02	-0,03	-0,03	0,150
Formal employment; construction	0,50	0,66	0,82	0,98	1,14	1,30	1,46	0,207
Retail sales	0,95	1,26	1,56	1,86	2,17	2,47	2,77	0,237
Retail sales; hypermarkets	1,07	1,40	1,74	2,07	2,41	2,74	3,08	0,360
Auto sales	3,33	4,44	5,55	6,65	7,76	8,87	9,98	0,037
Industrial production	0,05	0,08	0,11	0,15	0,18	0,21	0,24	0,290
Industrial production; consumption goods	0,35	0,46	0,57	0,69	0,80	0,91	1,02	0,110
Fixed capital absortion	0,34	0,54	0,74	0,93	1,13	1,33	1,53	0,300
Inputs to civil construction	0,99	1,31	1,62	1,94	2,26	2,58	2,89	0,040
Installed capacity utilization	0,23	0,31	0,39	0,48	0,56	0,64	0,72	0,017

Table 2. *Ex ante* effect of quantitative easing for the crisis sample

Accumulated Ex Ante Effect Average across QE rounds (%, unless otherwise noticed)	Crisis Sample 2006m01 to 2012m06							pvalue
	75	100	125	**150**	175	200	**225**	150
Price	-0,04	-0,06	-0,09	-0,11	-0,14	-0,16	-0,19	0,487
Activity	0,95	1,27	1,58	1,90	2,22	2,53	2,85	0,000
Inflow	4,20	5,59	6,98	8,37	9,76	11,15	12,54	0,000
Selic (p.p)	-1,07	-1,43	-1,80	-2,16	-2,52	-2,88	-3,25	0,000
Forex	-4,02	-5,30	-6,59	-7,87	-9,16	-10,45	-11,73	0,047
Non ear marked credit (%gdp)	0,39	0,50	0,61	0,72	0,83	0,94	1,05	0,427
Non ear marked credit; firms	0,11	0,13	0,16	0,19	0,22	0,24	0,27	0,220
Non ear marked credit; households	0,28	0,37	0,45	0,54	0,63	0,72	0,80	0,003
Credit from private banks	0,46	0,60	0,74	0,89	1,03	1,17	1,31	0,470
Credit from private banks; households	0,26	0,33	0,41	0,49	0,57	0,65	0,73	0,043
Credit from private banks; manufacture	0,12	0,16	0,20	0,24	0,28	0,31	0,35	0,467
Credit from private banks; retail	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,370
Credit from foreign banks	0,17	0,22	0,28	0,33	0,39	0,44	0,50	0,320
Credit from foreign banks; households	0,10	0,14	0,17	0,21	0,24	0,28	0,31	0,003
Credit from foreign banks; manufacture	0,05	0,06	0,08	0,09	0,11	0,12	0,14	0,210
Credit from foreign banks; retail	-0,02	-0,02	-0,03	-0,03	-0,04	-0,05	-0,05	0,090
Credit at risk; D or worse (%credit)	-0,30	-0,40	-0,50	-0,60	-0,70	-0,79	-0,89	0,000
Credit at risk; D or worse; households	-0,13	-0,16	-0,19	-0,23	-0,26	-0,29	-0,33	0,203
Credit at risk; D or worse; manufacture	-0,35	-0,47	-0,59	-0,70	-0,82	-0,93	-1,05	0,007
Credit at risk; D or worse; manuf+retail	-0,56	-0,74	-0,92	-1,10	-1,29	-1,47	-1,65	0,000
Interest rate; reference loans (p.p.)	-2,17	-2,90	-3,63	-4,36	-5,10	-5,83	-6,56	0,000
Interest rate; reference loans; households	-1,74	-2,35	-2,96	-3,56	-4,17	-4,78	-5,39	0,000
Interest rate; reference loans; firms	-2,44	-3,27	-4,09	-4,92	-5,74	-6,57	-7,39	0,000
Interest rate spread; reference loans	-0,79	-1,06	-1,33	-1,60	-1,87	-2,15	-2,42	0,017
Interest rate spread; reference loans; firms	-1,05	-1,41	-1,77	-2,13	-2,48	-2,84	-3,20	0,003
Stock market funds (%gdp)	0,59	0,78	0,98	1,18	1,37	1,57	1,77	0,000
Stock market value (%gdp)	5,53	7,43	9,33	11,23	13,13	15,03	16,93	0,000
Headline price index; services	-0,43	-0,58	-0,73	-0,88	-1,03	-1,18	-1,33	0,280
Headline price index; food	-0,12	-0,18	-0,25	-0,32	-0,39	-0,46	-0,52	0,347
Headline price index; core	-0,35	-0,47	-0,59	-0,70	-0,82	-0,94	-1,06	0,437
Producer price index	-0,81	-1,10	-1,39	-1,68	-1,98	-2,27	-2,56	0,010
Gross inflow; acm; direct investment	0,52	0,73	0,93	1,14	1,34	1,55	1,75	0,037
Gross inflow; acm; porfolio	6,68	8,83	10,99	13,14	15,29	17,44	19,59	0,000
Gross inflow; acm; credit	11,99	16,06	20,13	24,19	28,26	32,33	36,40	0,000
Export quantum	1,83	2,49	3,14	3,79	4,44	5,09	5,75	0,000
Import quantum	1,65	2,12	2,58	3,04	3,51	3,97	4,43	0,030
Import quantum; intermediate	1,14	1,53	1,92	2,31	2,70	3,09	3,48	0,050
International reserves (%gdp)	1,57	2,09	2,60	3,12	3,64	4,15	4,67	0,020
International reserves (%m2)	0,73	0,98	1,22	1,47	1,71	1,95	2,20	0,000
Unemployment rate (p.p)	0,02	0,03	0,04	0,06	0,07	0,08	0,09	0,337
Formal employment; retail and service	-0,08	-0,11	-0,14	-0,17	-0,20	-0,23	-0,25	0,083
Formal employment; construction	0,63	0,81	0,99	1,17	1,34	1,52	1,70	0,407
Retail sales	1,48	1,93	2,39	2,84	3,30	3,76	4,21	0,023
Retail sales; hypermarkets	0,43	0,54	0,65	0,75	0,86	0,97	1,07	0,480
Auto sales	4,55	6,14	7,72	9,31	10,89	12,48	14,06	0,000
Industrial production	1,17	1,60	2,02	2,44	2,87	3,29	3,71	0,000
Industrial production; consumption goods	0,82	1,11	1,40	1,69	1,98	2,27	2,56	0,007
Fixed capital absortion	1,31	1,78	2,24	2,71	3,17	3,64	4,11	0,027
Inputs to civil construction	1,01	1,33	1,65	1,97	2,29	2,62	2,94	0,097
Installed capacity utilization	0,49	0,66	0,83	1,01	1,18	1,36	1,53	0,000

Table 3. Channel decomposition of *ex ante* effect of quantitative easing for the full sample

Accumulated Effect by Channel — Full Sample

Average of QE rounds, considering +150 bp counterfactual — 2000m01 to 2012m06

	Price	Activity	Inflow	Selic	Forex	Total	
Price	0,01	0,08	-0,03	0,01	-0,74	-0,67	
Activity	0,00	0,30	0,38	-0,08	0,26	0,85	
Inflow	0,01	0,31	3,38	-0,13	0,01	3,58	
Selic	0,03	0,10	-0,54	0,16	-0,66	-0,90	
Forex	0,10	-0,76	-0,35	-0,14	-5,55	-6,69	
Median Share	-2%	9%	45%	-4%	73%	100%	
	Price	Activity	Inflow	Selic	Forex	Other	Total
Non ear marked credit (%gdp)	-0,02	0,06	0,16	-0,04	0,19	0,06	0,41
Non ear marked credit; firms	0,00	0,03	0,09	-0,01	0,11	-0,11	0,11
Non ear marked credit; households	-0,02	0,02	0,07	-0,02	0,07	0,20	0,32
Credit from private banks	0,00	0,04	0,14	-0,02	0,18	0,17	0,51
Credit from private banks; households	0,00	0,02	0,04	-0,01	0,05	0,22	0,32
Credit from private banks; manufacture	0,00	0,01	0,04	0,00	0,06	-0,03	0,08
Credit from private banks; retail	0,00	0,00	0,03	0,00	0,01	0,01	0,06
Credit from foreign banks	0,00	-0,01	0,00	-0,01	0,08	0,17	0,23
Credit from foreign banks; households	0,00	-0,01	0,01	0,00	0,02	0,11	0,13
Credit from foreign banks; manufacture	0,00	-0,01	0,01	-0,01	0,02	0,03	0,05
Credit from foreign banks; retail	0,00	-0,01	0,00	0,00	0,01	0,00	0,00
Credit at risk; D or worse (%credit)	0,00	0,03	-0,12	0,08	-0,10	0,01	-0,11
Credit at risk; D or worse; households	0,04	-0,04	-0,11	-0,03	-0,12	0,11	-0,15
Credit at risk; D or worse; manufacture	-0,01	-0,01	-0,01	0,04	-0,19	-0,04	-0,22
Credit at risk; D or worse; manuf+retail	-0,02	0,07	-0,09	0,10	-0,11	-0,20	-0,24
Interest rate; reference loans (p.p.)	-0,07	-0,17	-0,82	1,25	-1,02	-1,17	-1,99
Interest rate; reference loans; households	0,14	0,09	-0,99	0,72	-1,24	-1,78	-3,06
Interest rate; reference loans; firms	-0,21	-0,21	-0,62	0,20	-0,90	-0,21	-1,95
Interest rate spread; reference loans	-0,05	0,14	-0,49	0,24	-0,24	-0,77	-1,19
Interest rate spread; reference loans; firms	-0,04	0,06	-0,35	0,05	0,09	-1,16	-1,35
Stock market funds (%gdp)	0,00	-0,03	0,18	-0,02	-0,09	0,85	0,89
Stock market value (%gdp)	0,07	-0,07	2,19	-0,42	-0,06	4,90	6,62
Headline price index; services	-0,18	-0,05	0,09	0,05	-0,23	-0,02	-0,34
Headline price index; food	0,19	0,08	0,30	-0,04	-2,07	0,00	-1,53
Headline price index; core	-0,22	0,05	-0,08	0,19	-0,70	-0,08	-0,85
Producer price index	0,44	-0,17	-0,02	-0,07	-2,10	-1,69	-3,62
Gross inflow; acm; direct investment	0,02	-0,13	1,22	-0,04	-0,34	0,69	1,42
Gross inflow; acm; porfolio	0,05	0,44	2,12	-0,18	0,41	2,89	5,73
Gross inflow; acm; credit	-0,03	0,05	1,31	-0,37	0,14	6,97	8,06
Export quantum	-0,01	0,00	-1,43	0,19	-1,31	3,22	0,66
Import quantum	0,04	0,69	1,60	-0,24	1,67	1,73	5,50
Import quantum; intermediate	0,06	0,63	1,07	-0,19	1,56	1,88	5,00
International reserves (%gdp)	0,01	0,13	0,79	-0,01	-0,48	0,89	1,32
International reserves (%m2)	0,01	0,06	0,28	0,00	-0,25	0,41	0,51
Unemployment rate (p.p)	0,00	-0,02	-0,06	0,01	-0,03	0,11	0,02
Formal employment; retail and service	-0,03	0,06	0,01	0,00	0,19	-0,25	-0,02
Formal employment; construction	-0,03	0,23	0,25	-0,15	1,03	-0,34	0,98
Retail sales	-0,07	0,00	0,43	-0,16	1,28	0,39	1,86
Retail sales; hypermarkets	-0,04	0,01	0,40	-0,25	1,21	0,74	2,07
Auto sales	0,02	0,22	1,73	-0,70	1,81	3,56	6,65
Industrial production	-0,01	0,25	-0,10	-0,33	0,31	0,03	0,15
Industrial production; consumption goods	-0,02	0,38	-0,13	-0,12	0,57	0,02	0,69
Fixed capital absortion	-0,37	0,32	2,04	-0,16	2,73	-3,62	0,93
Inputs to civil construction	0,04	0,23	0,65	0,01	0,91	0,11	1,94
Installed capacity utilization	0,03	0,03	-0,07	-0,06	-0,01	0,55	0,48
Median Share	0%	5%	25%	-5%	35%	49%	100%

Table 4. Channel decomposition of *ex ante* effect of quantitative easing for the full sample

Accumulated Effect by Channel — Crisis Sample

Average of QE rounds, considering +150 bp counterfactual — 2006m01 to 2012m06

	Price	Activity	Inflow	Selic	Forex	Total	
Price	-1,08	0,00	0,94	0,26	-0,23	-0,11	
Activity	-0,39	0,29	1,37	0,68	-0,05	1,90	
Inflow	-1,69	0,31	8,99	0,82	-0,06	8,37	
Selic	0,40	0,05	-0,94	-1,72	0,06	-2,16	
Forex	-2,68	-0,29	-7,51	6,17	-3,57	-7,87	
Median Share	-18%	4%	72%	10%	-1%	100%	
	Price	Activity	Inflow	Selic	Forex	Other	Total
Non ear marked credit (%gdp)	0,00	0,13	1,06	-0,02	0,03	-0,48	0,72
Non ear marked credit; firms	-0,01	0,04	0,38	-0,10	0,03	-0,15	0,19
Non ear marked credit; households	0,05	0,05	0,57	0,07	0,11	-0,31	0,54
Credit from private banks	-0,04	0,20	1,03	-0,26	0,38	-0,43	0,89
Credit from private banks; households	-0,08	0,22	0,41	0,01	0,22	-0,30	0,49
Credit from private banks; manufacture	0,07	0,07	0,15	-0,15	0,10	0,00	0,24
Credit from private banks; retail	-0,01	0,00	0,08	-0,07	0,03	-0,02	0,01
Credit from foreign banks	0,08	0,00	0,15	-0,14	0,17	0,07	0,33
Credit from foreign banks; households	0,00	0,00	0,13	0,02	0,04	0,01	0,21
Credit from foreign banks; manufacture	0,03	0,00	-0,02	-0,03	0,05	0,06	0,09
Credit from foreign banks; retail	0,02	-0,01	0,03	-0,05	0,01	-0,03	-0,03
Credit at risk; D or worse (%credit)	-0,02	-0,03	-0,34	-0,15	0,03	-0,08	-0,60
Credit at risk; D or worse; households	0,05	-0,07	-0,26	-0,17	0,17	0,06	-0,23
Credit at risk; D or worse; manufacture	-0,15	0,00	-0,63	0,12	-0,10	0,06	-0,70
Credit at risk; D or worse; manuf+retail	-0,29	-0,04	-0,68	0,13	-0,17	-0,06	-1,10
Interest rate; reference loans (p.p.)	0,50	-0,01	-1,98	-2,73	0,56	-0,71	-4,36
Interest rate; reference loans; households	1,07	-0,12	-0,17	-4,50	1,19	-1,04	-3,56
Interest rate; reference loans; firms	-0,03	-0,10	-1,86	-1,82	0,05	-1,17	-4,92
Interest rate spread; reference loans	0,11	0,13	-1,04	-2,14	0,25	1,10	-1,60
Interest rate spread; reference loans; firms	-0,03	-0,06	-0,98	-0,65	-0,10	-0,31	-2,13
Stock market funds (%gdp)	0,12	-0,02	1,01	0,22	0,00	-0,16	1,18
Stock market value (%gdp)	1,45	0,01	8,74	2,02	0,16	-1,14	11,23
Headline price index; services	-3,66	0,01	0,11	0,16	-0,49	2,99	-0,88
Headline price index; food	-2,99	0,98	3,34	0,15	-0,02	-1,79	-0,32
Headline price index; core	-0,98	0,04	-0,02	-0,05	-0,12	0,43	-0,70
Producer price index	-0,28	-0,28	-0,15	0,03	0,24	-1,24	-1,68
Gross inflow; acm; direct investment	-1,15	-0,68	4,18	0,27	-1,02	-0,46	1,14
Gross inflow; acm; porfolio	-1,18	0,50	7,37	1,67	-0,11	4,89	13,14
Gross inflow; acm; credit	0,38	-0,49	0,96	1,06	1,88	20,41	24,19
Export quantum	-0,16	0,08	-1,27	0,31	0,02	4,81	3,79
Import quantum	-0,30	0,54	2,57	1,26	0,24	-1,26	3,04
Import quantum; intermediate	-0,08	0,61	1,48	0,75	0,82	-1,27	2,31
International reserves (%gdp)	0,01	0,10	1,79	0,13	-0,42	1,51	3,12
International reserves (%m2)	-0,08	0,02	0,66	0,15	-0,09	0,81	1,47
Unemployment rate (p.p)	0,05	-0,08	-0,15	0,11	-0,01	0,13	0,06
Formal employment; retail and service	0,15	0,00	-0,15	-0,21	0,21	-0,16	-0,17
Formal employment; construction	0,01	0,47	1,86	-0,73	-0,58	0,14	1,17
Retail sales	-1,08	0,04	0,84	0,17	0,17	2,71	2,84
Retail sales; hypermarkets	-1,52	0,01	0,67	0,48	-0,09	1,20	0,75
Auto sales	-2,50	1,17	7,37	4,52	-0,85	-0,40	9,31
Industrial production	0,86	-0,10	1,27	-1,18	0,87	0,72	2,44
Industrial production; consumption goods	0,75	-0,05	1,01	-0,64	0,52	0,11	1,69
Fixed capital absortion	0,74	2,49	2,68	-0,40	0,75	-3,56	2,71
Inputs to civil construction	0,04	0,08	1,88	-1,29	0,77	0,49	1,97
Installed capacity utilization	0,31	0,05	-0,34	0,10	0,11	0,77	1,01
Median Share	1%	2%	60%	9%	5%	12%	100%

Table 5. Pooled average test of *ex-post* effect for the full sample

Null Hypothesis: Pooled average ex-post effect = 0 Full Sample
p-values for N(0,1) test statistics 2000m01 to 2012m06

	75	100	125	**150**	175	200	**225**
Price	0,41	0,38	0,35	0,32	0,29	0,27	0,24
Activity	0,46	0,45	0,43	0,42	0,41	0,40	0,38
Inflow	0,34	0,29	0,24	0,20	0,16	0,13	0,10
Selic	0,46	0,44	0,43	0,41	0,40	0,39	0,37
Forex	0,39	0,36	0,32	0,29	0,25	0,22	0,20
non ear marked credit (%gdp)	0,47	0,46	0,45	0,44	0,43	0,42	0,41
non ear marked credit; firms	0,49	0,48	0,48	0,48	0,47	0,47	0,47
non ear marked credit; households	0,40	0,36	0,33	0,30	0,27	0,24	0,21
credit from private banks	0,45	0,43	0,41	0,40	0,38	0,36	0,35
credit from private banks; households	0,37	0,33	0,29	0,25	0,22	0,19	0,16
credit from private banks; manufacture	0,46	0,44	0,43	0,42	0,41	0,40	0,38
credit from private banks; retail	0,47	0,46	0,45	0,44	0,43	0,42	0,41
credit from foreign banks	0,45	0,44	0,42	0,41	0,40	0,38	0,37
credit from foreign banks; households	0,39	0,36	0,32	0,29	0,26	0,23	0,20
credit from foreign banks; manufacture	0,47	0,46	0,45	0,44	0,43	0,42	0,41
credit from foreign banks; retail	0,50	0,49	0,49	0,49	0,49	0,48	0,48
credit at risk; D or worse (p.p)	0,48	0,48	0,47	0,47	0,46	0,45	0,45
credit at risk; D or worse; households	0,49	0,49	0,48	0,48	0,48	0,47	0,47
credit at risk; D or worse; manufacture	0,45	0,43	0,42	0,40	0,38	0,37	0,35
credit at risk; D or worse; manuf+retail	0,46	0,44	0,43	0,42	0,40	0,39	0,38
interest rate; reference loans (p.p.)	0,43	0,41	0,39	0,36	0,34	0,32	0,30
interest rate; reference loans; households	0,45	0,43	0,41	0,39	0,37	0,36	0,34
interest rate; reference loans; firms	0,41	0,38	0,35	0,32	0,30	0,27	0,25
interest rate spread; reference loans	0,44	0,42	0,40	0,38	0,36	0,34	0,32
interest rate spread; reference loans; firms	0,40	0,37	0,34	0,31	0,29	0,26	0,23
stock market funds (%gdp)	0,29	0,23	0,17	0,13	0,09	0,07	0,04
stock market value	0,38	0,34	0,30	0,27	0,23	0,20	0,17
headline price index; services	0,48	0,47	0,46	0,45	0,44	0,44	0,43
headline price index; food	0,44	0,42	0,40	0,38	0,36	0,35	0,33
headline price index; core	0,28	0,22	0,17	0,13	0,09	0,07	0,05
producer price index	0,35	0,30	0,26	0,22	0,18	0,15	0,12
gross inflow; acm; direct investment	0,45	0,44	0,42	0,41	0,40	0,38	0,37
gross inflow; acm; porfolio	0,38	0,34	0,31	0,27	0,24	0,21	0,18
gross inflow; acm; credit	0,40	0,37	0,34	0,31	0,28	0,25	0,23
export quantum	0,49	0,49	0,49	0,49	0,49	0,48	0,48
import quantum	0,45	0,43	0,41	0,40	0,38	0,37	0,35
import quantum; intermediate	0,45	0,43	0,42	0,40	0,39	0,37	0,36
international reserves (%gdp)	0,42	0,40	0,37	0,35	0,32	0,30	0,28
international reserves (%m2)	0,31	0,25	0,20	0,16	0,12	0,09	0,06
unemployment rate	0,50	0,50	0,50	0,50	0,49	0,49	0,49
formal employment; retail and service	0,49	0,49	0,49	0,48	0,48	0,48	0,47
formal employment; construction	0,37	0,33	0,29	0,25	0,22	0,19	0,16
retail sales	0,43	0,41	0,39	0,37	0,35	0,33	0,31
retail sales; hypermarkets	0,42	0,39	0,37	0,34	0,32	0,29	0,27
auto sales	0,47	0,46	0,45	0,44	0,43	0,42	0,41
industrial production	0,50	0,50	0,50	0,50	0,49	0,49	0,49
industrial production; consumption goods	0,49	0,48	0,48	0,47	0,47	0,46	0,46
fixed capital absortion	0,49	0,49	0,48	0,48	0,47	0,47	0,47
inputs to civil construction	0,42	0,39	0,37	0,34	0,32	0,30	0,27
installed capacity utilization	0,47	0,45	0,44	0,43	0,42	0,40	0,39

Table 6. Pooled average test of *ex-post* effect for the crisis sample

Null Hypothesis: Pooled average ex-post effect = 0 Crisis Sample
p-values for N(0,1) test statistics 2006m01 to 2012m06

	75	100	125	**150**	175	200	**225**
Price	0,49	0,48	0,48	0,47	0,46	0,46	0,45
Activity	0,43	0,41	0,39	0,37	0,34	0,32	0,30
Inflow	0,16	0,09	0,05	0,02	0,01	0,00	0,00
Selic	0,15	0,08	0,04	0,02	0,01	0,00	0,00
Forex	0,41	0,39	0,36	0,34	0,31	0,29	0,26
non ear marked credit (%gdp)	0,39	0,36	0,34	0,31	0,28	0,26	0,23
non ear marked credit; firms	0,45	0,44	0,43	0,42	0,41	0,40	0,38
non ear marked credit; households	0,24	0,17	0,12	0,08	0,05	0,03	0,02
credit from private banks	0,33	0,28	0,23	0,19	0,16	0,13	0,10
credit from private banks; households	0,21	0,15	0,10	0,06	0,04	0,02	0,01
credit from private banks; manufacture	0,36	0,31	0,27	0,24	0,20	0,17	0,14
credit from private banks; retail	0,49	0,48	0,48	0,48	0,48	0,47	0,47
credit from foreign banks	0,32	0,26	0,22	0,17	0,14	0,10	0,08
credit from foreign banks; households	0,28	0,22	0,17	0,12	0,09	0,06	0,04
credit from foreign banks; manufacture	0,39	0,35	0,32	0,29	0,26	0,23	0,20
credit from foreign banks; retail	0,43	0,40	0,38	0,35	0,33	0,31	0,28
credit at risk; D or worse (p.p)	0,26	0,20	0,15	0,11	0,07	0,05	0,03
credit at risk; D or worse; households	0,48	0,47	0,47	0,46	0,46	0,45	0,45
credit at risk; D or worse; manufacture	0,34	0,29	0,24	0,20	0,16	0,13	0,11
credit at risk; D or worse; manuf+retail	0,22	0,16	0,10	0,07	0,04	0,02	0,01
interest rate; reference loans (p.p.)	0,35	0,30	0,26	0,21	0,18	0,15	0,12
interest rate; reference loans; households	0,41	0,37	0,34	0,31	0,29	0,26	0,23
interest rate; reference loans; firms	0,25	0,19	0,13	0,09	0,06	0,04	0,02
interest rate spread; reference loans	0,46	0,44	0,43	0,41	0,40	0,38	0,37
interest rate spread; reference loans; firms	0,41	0,38	0,35	0,32	0,29	0,27	0,24
stock market funds (%gdp)	0,26	0,19	0,14	0,10	0,07	0,04	0,03
stock market value	0,33	0,28	0,23	0,18	0,15	0,11	0,09
headline price index; services	0,43	0,40	0,38	0,35	0,33	0,31	0,28
headline price index; food	0,48	0,47	0,46	0,45	0,44	0,44	0,43
headline price index; core	0,27	0,20	0,15	0,10	0,07	0,05	0,03
producer price index	0,40	0,37	0,34	0,31	0,28	0,25	0,22
gross inflow; acm; direct investment	0,47	0,45	0,44	0,43	0,41	0,40	0,39
gross inflow; acm; porfolio	0,22	0,15	0,10	0,07	0,04	0,02	0,01
gross inflow; acm; credit	0,23	0,16	0,11	0,07	0,04	0,02	0,01
export quantum	0,45	0,44	0,42	0,40	0,39	0,37	0,36
import quantum	0,46	0,45	0,44	0,43	0,42	0,42	0,41
import quantum; intermediate	0,47	0,46	0,45	0,44	0,43	0,42	0,41
international reserves (%gdp)	0,25	0,19	0,14	0,09	0,06	0,04	0,02
international reserves (%m2)	0,05	0,02	0,00	0,00	0,00	0,00	0,00
unemployment rate	0,49	0,49	0,49	0,48	0,48	0,47	0,47
formal employment; retail and service	0,45	0,43	0,41	0,39	0,37	0,35	0,33
formal employment; construction	0,39	0,36	0,34	0,31	0,28	0,26	0,23
retail sales	0,35	0,31	0,27	0,23	0,20	0,17	0,14
retail sales; hypermarkets	0,47	0,46	0,45	0,45	0,44	0,43	0,42
auto sales	0,46	0,44	0,43	0,41	0,40	0,38	0,37
industrial production	0,45	0,43	0,42	0,40	0,38	0,36	0,35
industrial production; consumption goods	0,47	0,46	0,45	0,44	0,43	0,42	0,41
fixed capital absortion	0,48	0,47	0,46	0,45	0,45	0,44	0,43
inputs to civil construction	0,42	0,40	0,38	0,35	0,33	0,31	0,29
installed capacity utilization	0,44	0,41	0,39	0,37	0,35	0,33	0,31

Table 7. Each average test of *ex-post* effect for the full sample

Null Hypothesis: Each average ex-post effect = 0 Full Sample
p-values for ChiSq(4) test statistics 2000m01 to 2012m06

	75	100	125	**150**	175	200	**225**
Price	0,96	0,91	0,83	0,73	0,61	0,49	0,37
Activity	1,00	1,00	0,99	0,98	0,97	0,96	0,93
Inflow	0,89	0,75	0,57	0,38	0,23	0,12	0,05
Selic	0,99	0,99	0,97	0,95	0,92	0,89	0,84
Forex	0,90	0,80	0,67	0,53	0,38	0,25	0,16
non ear marked credit (%gdp)	1,00	1,00	1,00	0,99	0,98	0,97	0,96
non ear marked credit; firms	1,00	1,00	0,99	0,98	0,97	0,96	0,94
non ear marked credit; households	0,96	0,91	0,82	0,71	0,58	0,45	0,33
credit from private banks	1,00	0,99	0,98	0,96	0,93	0,89	0,84
credit from private banks; households	0,94	0,85	0,73	0,58	0,42	0,29	0,18
credit from private banks; manufacture	0,96	0,92	0,85	0,77	0,67	0,56	0,44
credit from private banks; retail	1,00	1,00	1,00	0,99	0,99	0,98	0,97
credit from foreign banks	0,99	0,98	0,95	0,91	0,85	0,77	0,68
credit from foreign banks; households	0,95	0,88	0,78	0,66	0,52	0,38	0,26
credit from foreign banks; manufacture	0,98	0,96	0,93	0,87	0,80	0,72	0,63
credit from foreign banks; retail	1,00	1,00	1,00	1,00	0,99	0,99	0,99
credit at risk; D or worse (p.p)	0,94	0,89	0,82	0,72	0,61	0,49	0,37
credit at risk; D or worse; households	0,99	0,97	0,94	0,90	0,85	0,79	0,71
credit at risk; D or worse; manufacture	0,62	0,43	0,27	0,14	0,07	0,03	0,01
credit at risk; D or worse; manuf+retail	0,98	0,95	0,91	0,85	0,78	0,69	0,59
interest rate; reference loans (p.p.)	0,97	0,95	0,91	0,85	0,78	0,70	0,61
interest rate; reference loans; households	1,00	0,99	0,98	0,96	0,94	0,90	0,86
interest rate; reference loans; firms	0,67	0,50	0,32	0,19	0,09	0,04	0,02
interest rate spread; reference loans	0,98	0,97	0,94	0,89	0,84	0,77	0,69
interest rate spread; reference loans; firms	0,85	0,72	0,56	0,40	0,26	0,15	0,08
stock market funds (%gdp)	0,75	0,53	0,31	0,15	0,06	0,02	0,01
stock market value	0,94	0,87	0,76	0,63	0,49	0,36	0,24
headline price index; services	1,00	0,99	0,99	0,98	0,97	0,95	0,93
headline price index; food	0,99	0,98	0,96	0,93	0,88	0,83	0,76
headline price index; core	0,62	0,38	0,18	0,07	0,02	0,00	0,00
producer price index	0,81	0,62	0,41	0,23	0,11	0,05	0,02
gross inflow; acm; direct investment	1,00	1,00	0,99	0,99	0,98	0,97	0,95
gross inflow; acm; porfolio	0,00	0,00	0,00	0,00	0,00	0,00	0,00
gross inflow; acm; credit	0,96	0,91	0,83	0,73	0,61	0,48	0,36
export quantum	0,47	0,27	0,13	0,05	0,02	0,00	0,00
import quantum	0,68	0,49	0,31	0,17	0,08	0,03	0,01
import quantum; intermediate	0,49	0,27	0,12	0,05	0,01	0,00	0,00
international reserves (%gdp)	0,89	0,78	0,64	0,48	0,33	0,21	0,12
international reserves (%m2)	0,68	0,44	0,24	0,10	0,04	0,01	0,00
unemployment rate	0,97	0,95	0,92	0,88	0,82	0,75	0,68
formal employment; retail and service	1,00	0,99	0,98	0,97	0,95	0,92	0,89
formal employment; construction	0,89	0,77	0,62	0,45	0,29	0,17	0,09
retail sales	0,94	0,89	0,82	0,73	0,62	0,51	0,40
retail sales; hypermarkets	0,78	0,66	0,51	0,37	0,25	0,15	0,09
auto sales	0,98	0,95	0,92	0,87	0,80	0,73	0,64
industrial production	0,93	0,86	0,77	0,65	0,53	0,40	0,29
industrial production; consumption goods	1,00	1,00	0,99	0,99	0,98	0,97	0,96
fixed capital absortion	0,35	0,17	0,07	0,02	0,00	0,00	0,00
inputs to civil construction	0,41	0,23	0,10	0,04	0,01	0,00	0,00
installed capacity utilization	0,95	0,91	0,83	0,73	0,61	0,49	0,37

Table 8. Each average test of *ex-post* effect for the crisis sample

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

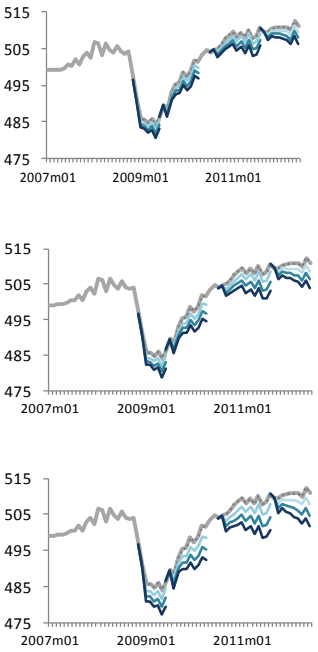
Table 9. Each average test of *ex-post* effect for the crisis sample (bootstrapped test statistic)

Null Hypothesis: Each average ex-post effect = 0 Crisis Sample
p-values for ChiSq(4) test statistics 2006m01 to 2012m06

	75	100	125	**150**	175	200	**225**
Price	0,01	0,01	0,01	0,01	0,01	0,01	0,01
Activity	0,11	0,11	0,10	0,09	0,09	0,09	0,09
Inflow	0,05	0,04	0,04	0,04	0,04	0,03	0,03
Selic	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Forex	0,19	0,13	0,11	0,09	0,08	0,08	0,08
non ear marked credit (%gdp)	0,01	0,01	0,01	0,01	0,01	0,01	0,01
non ear marked credit; firms	0,04	0,04	0,04	0,04	0,04	0,04	0,04
non ear marked credit; households	0,00	0,00	0,00	0,00	0,00	0,00	0,00
credit from private banks	0,03	0,03	0,03	0,03	0,02	0,02	0,02
credit from private banks; households	0,00	0,00	0,00	0,00	0,00	0,00	0,00
credit from private banks; manufacture	0,22	0,19	0,16	0,14	0,13	0,13	0,13
credit from private banks; retail	0,87	0,87	0,87	0,87	0,87	0,88	0,88
credit from foreign banks	0,01	0,01	0,01	0,01	0,01	0,01	0,01
credit from foreign banks; households	0,00	0,00	0,00	0,00	0,00	0,00	0,00
credit from foreign banks; manufacture	0,03	0,02	0,02	0,02	0,02	0,02	0,02
credit from foreign banks; retail	0,02	0,02	0,02	0,02	0,02	0,02	0,02
credit at risk; D or worse (p.p)	0,03	0,02	0,02	0,02	0,01	0,01	0,01
credit at risk; D or worse; households	0,03	0,03	0,03	0,03	0,03	0,03	0,03
credit at risk; D or worse; manufacture	0,50	0,44	0,40	0,36	0,34	0,32	0,30
credit at risk; D or worse; manuf+retail	0,00	0,00	0,00	0,00	0,00	0,00	0,00
interest rate; reference loans (p.p.)	0,02	0,01	0,01	0,01	0,01	0,01	0,01
interest rate; reference loans; households	0,00	0,00	0,00	0,00	0,00	0,00	0,00
interest rate; reference loans; firms	0,00	0,00	0,00	0,00	0,00	0,00	0,00
interest rate spread; reference loans	0,05	0,04	0,04	0,04	0,04	0,04	0,04
interest rate spread; reference loans; firms	0,01	0,01	0,01	0,01	0,01	0,01	0,01
stock market funds (%gdp)	0,00	0,00	0,00	0,00	0,00	0,00	0,00
stock market value	0,03	0,02	0,02	0,02	0,02	0,02	0,02
headline price index; services	0,03	0,02	0,02	0,02	0,02	0,02	0,02
headline price index; food	0,00	0,00	0,00	0,00	0,00	0,00	0,00
headline price index; core	0,00	0,00	0,00	0,00	0,00	0,00	0,00
producer price index	0,29	0,28	0,25	0,24	0,23	0,22	0,22
gross inflow; acm; direct investment	0,11	0,12	0,12	0,12	0,12	0,12	0,13
gross inflow; acm; porfolio	0,01	0,01	0,01	0,01	0,01	0,01	0,01
gross inflow; acm; credit	0,06	0,05	0,05	0,05	0,05	0,05	0,05
export quantum	0,70	0,71	0,71	0,72	0,72	0,72	0,72
import quantum	0,40	0,39	0,38	0,37	0,37	0,37	0,37
import quantum; intermediate	0,58	0,57	0,57	0,57	0,57	0,57	0,57
international reserves (%gdp)	0,02	0,02	0,02	0,02	0,02	0,02	0,02
international reserves (%m2)	0,00	0,00	0,00	0,00	0,00	0,00	0,00
unemployment rate	0,34	0,33	0,34	0,34	0,35	0,35	0,35
formal employment; retail and service	0,09	0,07	0,07	0,07	0,07	0,07	0,07
formal employment; construction	0,00	0,00	0,00	0,00	0,00	0,00	0,00
retail sales	0,09	0,09	0,09	0,09	0,08	0,08	0,08
retail sales; hypermarkets	0,18	0,19	0,19	0,19	0,19	0,19	0,19
auto sales	0,45	0,45	0,45	0,45	0,45	0,45	0,45
industrial production	0,00	0,00	0,00	0,00	0,00	0,00	0,00
industrial production; consumption goods	0,08	0,08	0,08	0,08	0,08	0,08	0,08
fixed capital absortion	0,02	0,02	0,02	0,02	0,02	0,02	0,02
inputs to civil construction	0,06	0,05	0,05	0,05	0,05	0,05	0,05
installed capacity utilization	0,07	0,07	0,07	0,07	0,07	0,07	0,07

Table 10. *Ex ante* effects under different priors for the global activity channel

Counterfactuals on world trade
Stronger priors on global acitivity channel



Accumulated Ex Ante Effect
Average across QE rounds

Full Sample
2000m01 to 2012m06

lambda = 1.0	**75**	100	125	**150**	175	200	**225**
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

lambda = 1.5	**75**	100	125	**150**	175	200	**225**
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

lambda = 2.0	**75**	100	125	**150**	175	200	**225**
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

Figure 1. Policy Counterfactuals

Ligh Blue = 75 bp; Blue = 150 bp; Dark Blue = 225 bp

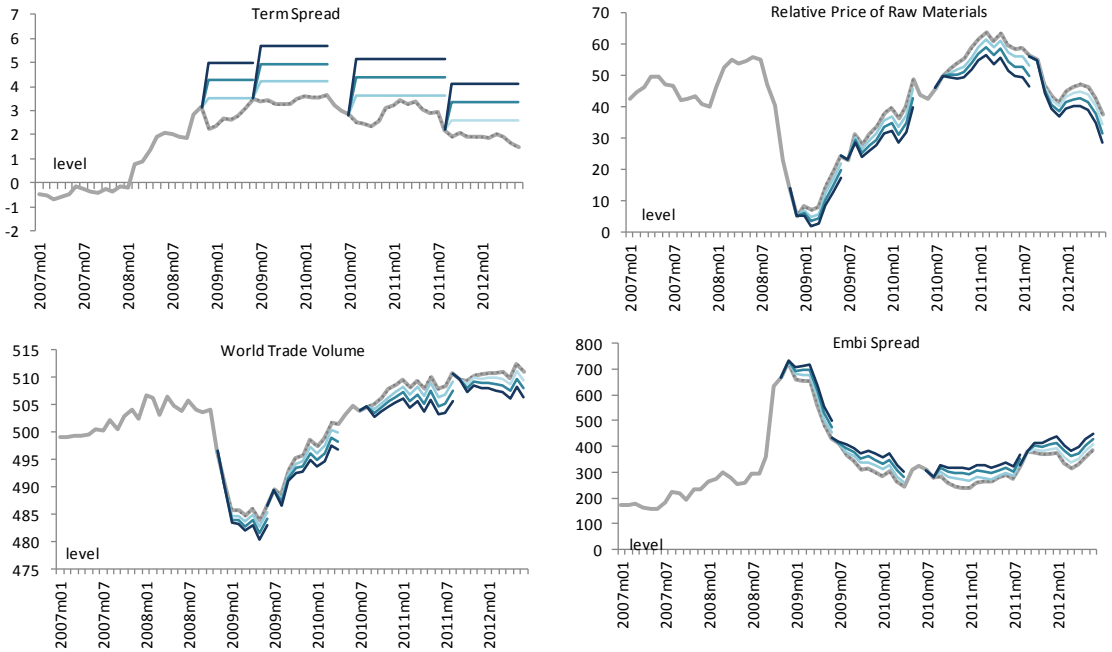


Figure 2. *Ex Ante* Forecasts for the Core Variables

Dotted = Actual policy; Ligh Blue = 75 bp; Blue = 150 bp; Dark Blue = 225 bp

LHS = Full Sample; RHS = Crisis Sample

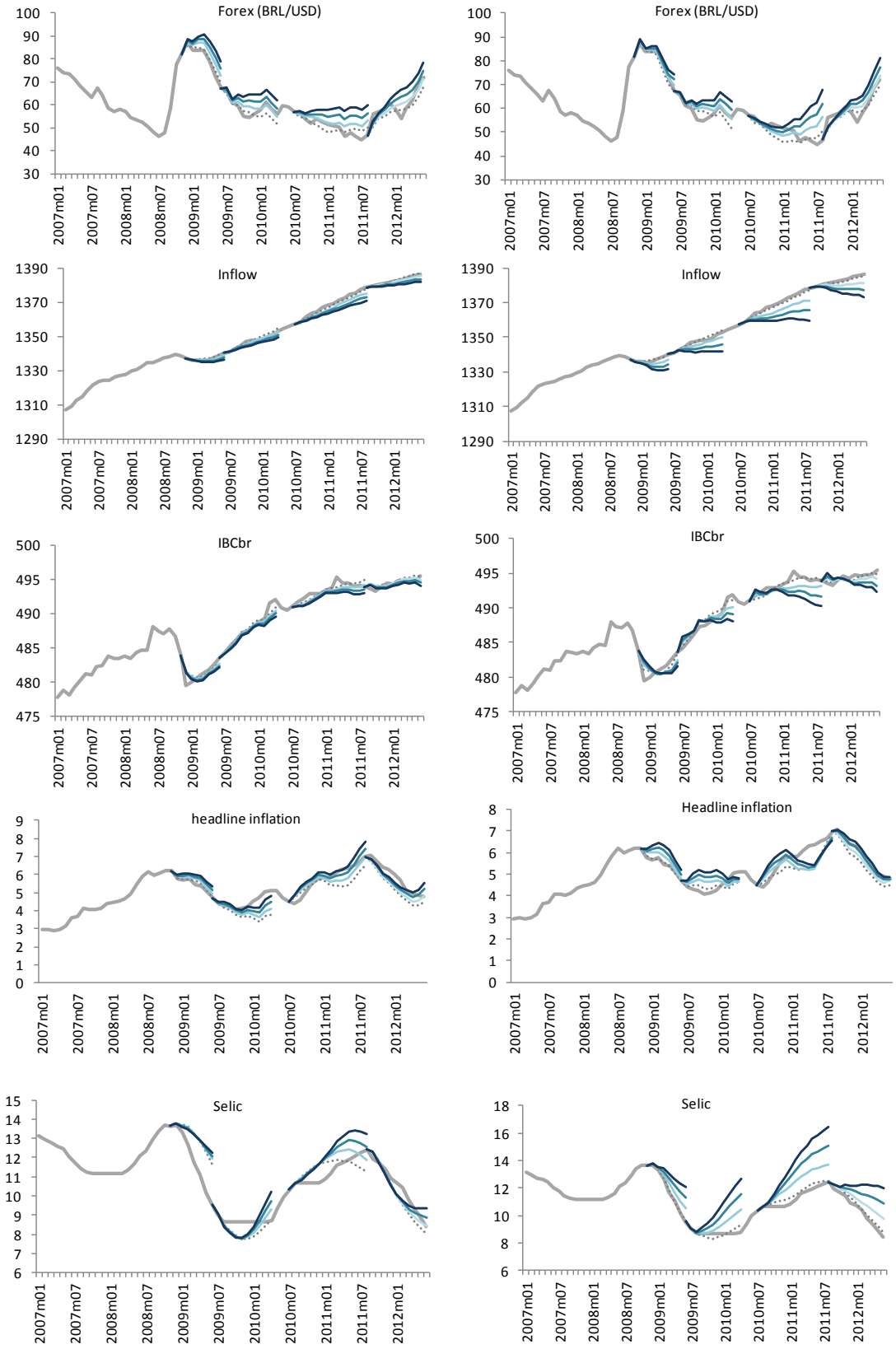


Figure 3. Channel decomposition of core variables for the full sample

Full Sample: 2000m01 – 2012m06

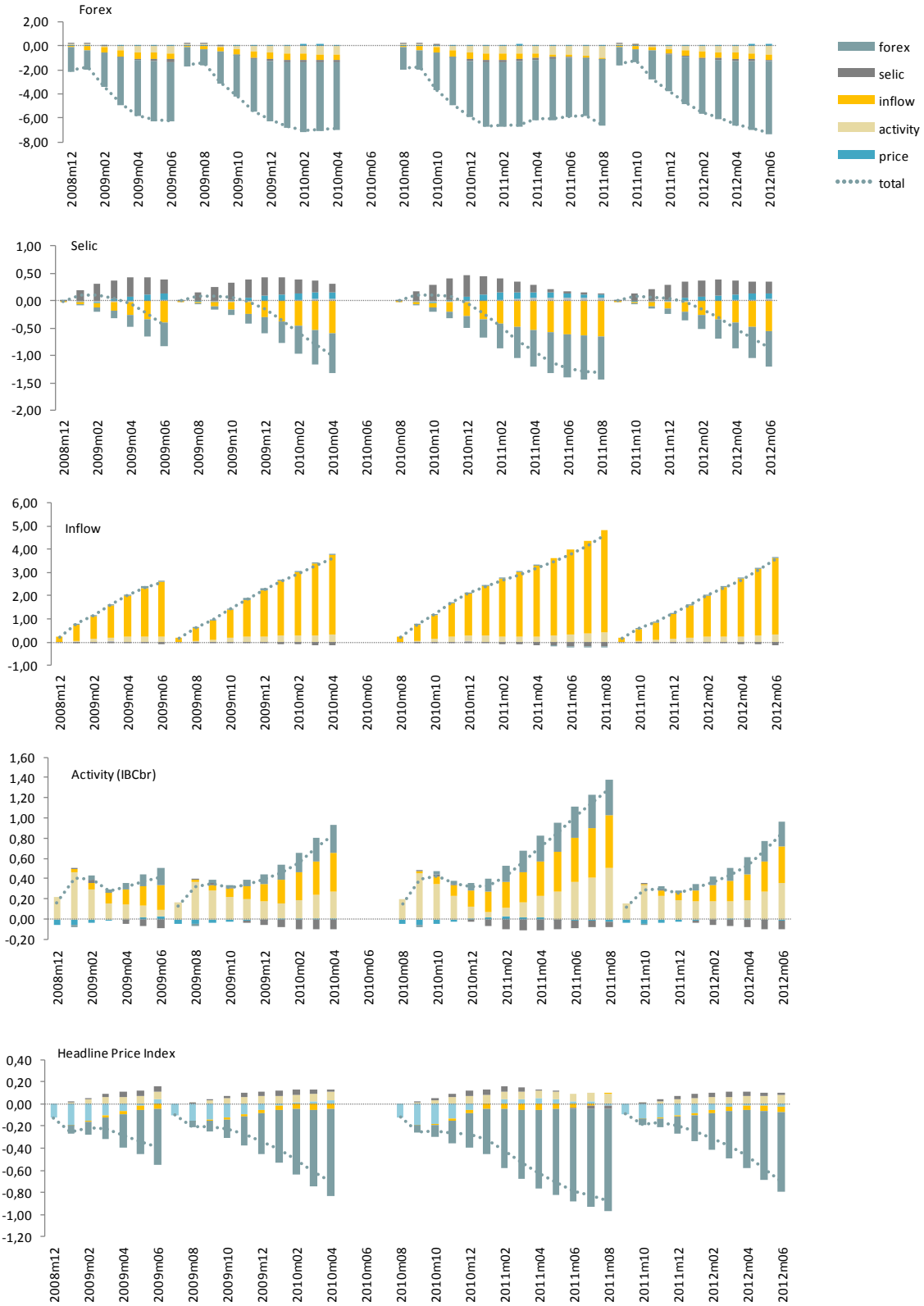
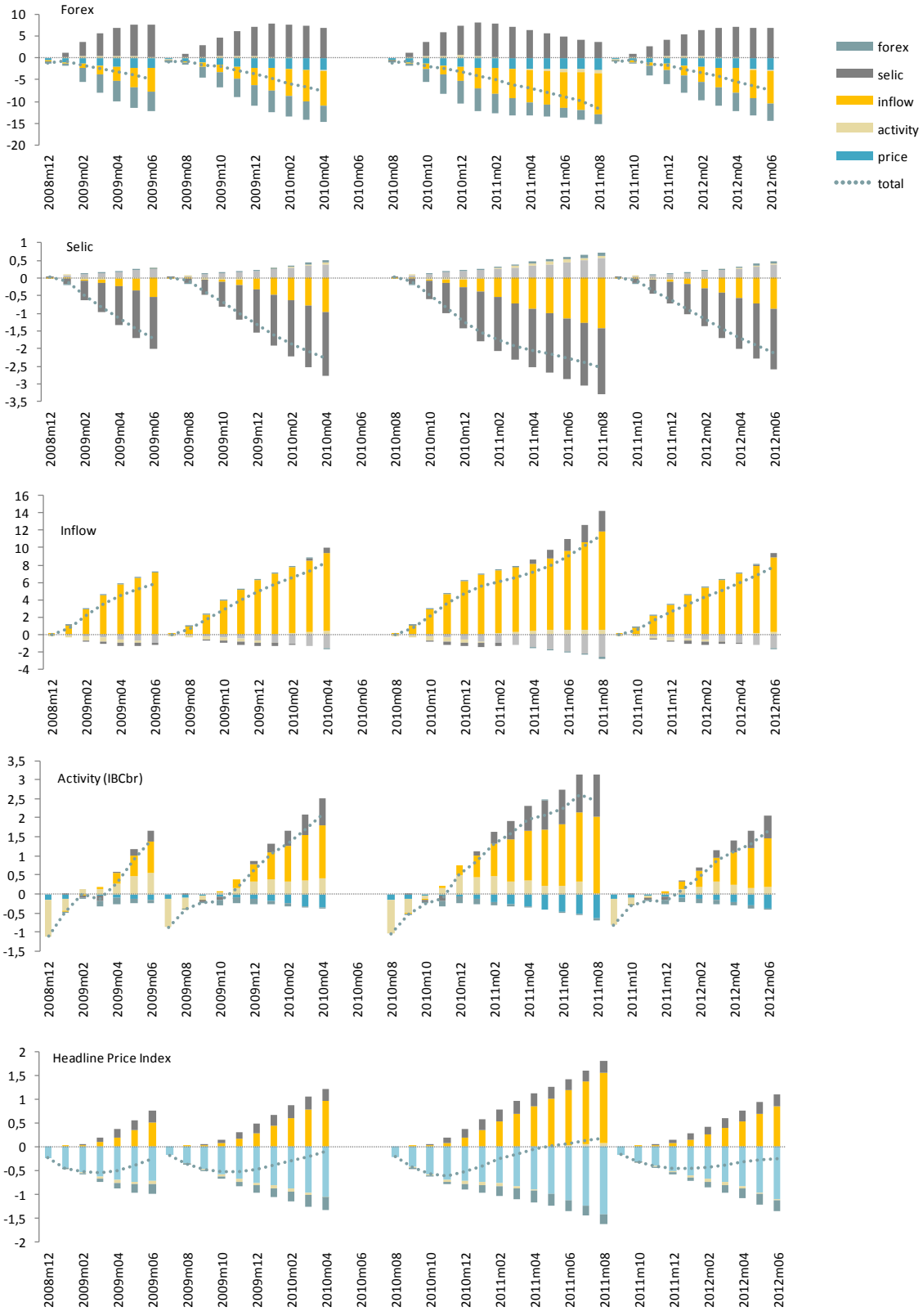


Figure 3. Channel decomposition of core variables for the crisis sample

Crisis Sample: 2006m01 – 2012m06



Appendix A: Proof

Equation (9) states that the sum of marginal channel effects is equal to the total ex ante effect. The proof is by induction. First, we establish the equation for h=1.

$$\sum_{i=1..n} \boldsymbol{d}_{t+1}^{channel(i)} = \sum_{i=1..n} \left(F^a z_{t+1} - F^{(a_{-i},c_i)} z_{t+1}\right)$$

$$= \sum_{i=1..n} \left(\begin{pmatrix} A^1(L)(F^a z_t, x_t^a) \\ \vdots \\ A^i(L)(F^a z_t, x_t^a) \\ \vdots \\ A^n(L)(F^a z_t, x_t^a) \end{pmatrix} - \begin{pmatrix} A^1(L)\left(F^{(a_{-i},c_i)} z_t, x_t^a\right) \\ \vdots \\ A^i(L)\left(F^{(a_{-i},c_i)} z_t, x_t^c\right) \\ \vdots \\ A^n(L)\left(F^{(a_{-i},c_i)} z_t, x_t^a\right) \end{pmatrix} \right)$$

$$= \sum_{i=1..n} \left(\begin{pmatrix} A^1(L)(z_t, x_t^a) \\ \vdots \\ A^i(L)(z_t, x_t^a) \\ \vdots \\ A^n(L)(z_t, x_t^a) \end{pmatrix} - \begin{pmatrix} A^1(L)(z_t, x_t^a) \\ \vdots \\ A^i(L)(z_t, x_t^c) \\ \vdots \\ A^n(L)(z_t, x_t^a) \end{pmatrix} \right)$$

$$= \sum_{i=1..n} \begin{pmatrix} 0 \\ \vdots \\ A^i(L)(z_t, x_t^a) - A^i(L)(z_t, x_t^c) \\ \vdots \\ 0 \end{pmatrix}$$

$$= \begin{pmatrix} A^1(L)(z_t, x_{t-1}^a) - A^1(L)(z_t, x_{t-1}^c) \\ \vdots \\ A^i(L)(z_t, x_{t-1}^a) - A^i(L)(z_t, x_{t-1}^c) \\ \vdots \\ A^n(L)(z_t, x_{t-1}^a) - A^n(L)(z_t, x_{t-1}^c) \end{pmatrix}$$

$$= \begin{pmatrix} A^1(L)(F^a z_t, x_t^a) - A^1(L)\left(F^{(a_{-i},c_i)} z_t, x_t^c\right) \\ \vdots \\ A^i(L)(F^a z_t, x_t^a) - A^i(L)\left(F^{(a_{-i},c_i)} z_t, x_t^c\right) \\ \vdots \\ A^n(L)(F^a z_t, x_t^a) - A^n(L)\left(F^{(a_{-i},c_i)} z_t, x_t^c\right) \end{pmatrix}$$

$$= F^a z_{t+1} - F^c z_{t+1},$$

$$= \boldsymbol{d}_{t+1}^{ex\ ante}$$

Now suppose the equation holds for h. We show it holds for h+1.

$$\sum_{i=1..n} \boldsymbol{d}_{t+h+1}^{channel(i)} = \sum_{i=1..n} \left(F^a z_{t+h+1} - F^{(a_{-i},c_i)} z_{t+h+1}\right)$$

$$= \sum_{i=1..n} \left(\begin{pmatrix} A^1(L)(F^a z_{t+h}, x^a_{t+h}) \\ \vdots \\ A^i(L)(F^a z_{t+h}, x^a_{t+h}) \\ \vdots \\ A^n(L)(F^a z_{t+h}, x^a_{t+h}) \end{pmatrix} - \begin{pmatrix} A^1(L)\left(F^{(a_{-i},c_i)} z_{t+h}, x^a_{t+h}\right) \\ \vdots \\ A^i(L)\left(F^{(a_{-i},c_i)} z_{t+h}, x^c_{t+h}\right) \\ \vdots \\ A^n(L)\left(F^{(a_{-i},c_i)} z_{t+h}, x^a_{t+h}\right) \end{pmatrix} \right)$$

$$= \sum_{i=1..n} \left(\begin{pmatrix} A^1_z(L)F^a z_{t+h} \\ \vdots \\ A^i_z(L)F^a z_{t+h} \\ \vdots \\ A^n_z(L)F^a z_{t+h} \end{pmatrix} - \begin{pmatrix} A^1_z(L)F^{(a_{-i},c_i)} z_{t+h} \\ \vdots \\ A^i_z(L)F^{(a_{-i},c_i)} z_{t+h} \\ \vdots \\ A^n_z(L)F^{(a_{-i},c_i)} z_{t+h} \end{pmatrix}, \begin{pmatrix} A^1_x(L)x^a_{t+h} \\ \vdots \\ A^i_x(L)x^a_{t+h} \\ \vdots \\ A^n_x(L)x^a_{t+h} \end{pmatrix} - \begin{pmatrix} A^1_x(L)x^a_{t+h} \\ \vdots \\ A^i_x(L)x^c_{t+h} \\ \vdots \\ A^n_x(L)x^a_{t+h} \end{pmatrix} \right)$$

$$= \sum_{i=1..n} \left(A_z(L)F^a z_{t+h} - A_z(L)F^{(a_{-i},c_i)} z_{t+h}, \begin{pmatrix} 0 \\ \vdots \\ A^i_x(L)x^a_{t+h} - A^i_x(L)x^c_{t+h} \\ \vdots \\ 0 \end{pmatrix} \right)$$

$$= \left(A_z(L) \sum_{i=1..n} \left(F^a z_{t+h} - F^{(a_{-i},c_i)} z_{t+h}\right), \sum_{i=1..n} \begin{pmatrix} 0 \\ \vdots \\ A^i_x(L)x^a_{t+h} - A^i_x(L)x^c_{t+h} \\ \vdots \\ 0 \end{pmatrix} \right)$$

$$= \begin{pmatrix} A^1_x(L)x^a_{t+h} - A^1_x(L)x^c_{t+h} \\ \vdots \\ A_z(L)(F^a z_{t+h} - F^c z_{t+h}), A^i_x(L)x^a_{t+h} - A^i_x(L)x^c_{t+h} \\ \vdots \\ A^n_x(L)x^a_{t+h} - A^n_x(L)x^c_{t+h} \end{pmatrix}$$

$$= \begin{pmatrix} A^1(L)(F^a z_{t+h}, x^a_{t+h}) - A^1(L)(F^c z_{t+h}, x^c_{t+h}) \\ \vdots \\ A^i(L)(F^a z_{t+h}, x^a_{t+h}) - A^i(L)(F^c z_{t+h}, x^c_{t+h}) \\ \vdots \\ A^n(L)(F^a z_{t+h}, x^a_{t+h}) - A^n(L)(F^c z_{t+h}, x^c_{t+h}) \end{pmatrix}$$

$$= F^a z_{t+h+1} - F^c z_{t+h+1}$$

$$= \boldsymbol{d}^{ex\ ante}_{t+h+1}$$

And this completes the proof. The linearity of the forecasting model is the essential property to obtain the equation.

Appendix B: Additional variables

Section 4.1 describes and provides the sources of the core variables of the model. This appendix covers the additional variables investigated in the paper. As before, the sample ranges from January, 2000 to June, 2012. All the variables refer to the Brazilian economy. They are measured either in logarithms or in percentage points. Therefore, as for the core variables, the policy effects should be interpreted as percentage changes (or point changes) of actual (or foreseeable) levels relative to counterfactual levels.

The credit block includes the following variables measured as a percentage of GDP: stock of nor earmarked credit (total, firms, households); stock of credit from private banks (total, households, manufacture, retail); and stock credit from foreign banks (total, households, manufacture, retail). The same block also includes indicators of credit at risk, measured as the share of credit classified as D or worse by financial institutions, both total and disaggregated for households manufacture and retail. The dataset also includes interest rates and interest rate spreads for reference loans measured in percentage points, either aggregated or disaggregated into household and firms loans. All the credit variables are maintained by the Central Bank of Brazil.

The market capitalization of the Bovespa stock exchange and the market value of funds investing in the exchange, are both measured as a share of GDP, have as source the Bovespa.

Besides the headline price index included in the core set of variables, we also considered the services, food and core components of the index, as reported by the Central Bank of Brazil. The price block also includes the producer price index represented by the IPA for industrial goods, obtained from the same source. We also considered the relative price of non tradables, the general price index and the producer price index, full and for agricultural goods only, but these variables were excluded by our selection criteria, that is, inconsistent behavior in the crisis and full sample.

The additional capital inflow variables provide more disaggregated information relative to the core capital flow variable. The gross inflow of foreign direct investment, portfolio and credit where included, all measured as accumulated flows starting from the net external liabilities under each rubric in January 1995. As for the core variable, the disaggregate figures are measured in dollars, and "gross" means only nonresident flows. The net external liabilities positions are from the International Investment Position report by the Central Bank of Brazil and the flow variables are from the same institution

compilation of the capital account. It should be stressed that the Central Bank of Brazil has very comprehensive coverage of all these statistics.

Other international variables considered in the paper, provided by Funcex, a foundation dedicated to external trade statistics and research, were the aggregate export quantum index, and the aggregate and intermediate goods import quantum indexes. International reserves were measured either as a share of GDP in dollar or as share of M2, and such variables are calculated by the Central Bank of Brazil. Variables we experimented with but discarded by our selection criteria were the import quantum of capital goods and the current account as a share of GDP.

The domestic activity variables are from the official national statistical agency IBGE, and include the unemployment rate, formal employment (retail, service and construction), retail sales (total, hypermarkets), auto sales, industrial production (total, consumption goods), fixed capital absorption and inputs to civil construction. The installed capacity utilization variable is from FGV, a foundation dedicated to economic research among other goals. Some variables from IBGE were investigated but discarded by selection criteria, including labor payroll, total formal employment and industrial production of capital goods.

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