Fiscal Dominance in High-Frequency Data*

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Preliminary. Comments welcome.

Abstract

In a situation of fiscal stress, interest rate hikes can lead to depreciation and inflation pressures. This unintended effects arise because higher interest rate differential is insufficient to offset a higher currency risk premium, which is in turn driven by higher probability of sovereign default. We build on this intuition advanced by Blanchard (2004) and propose a novel approach to evaluate the presence of fiscal dominance by studying daily data around central bank decisions. We apply the approach to Brazilian data and show that interest rate hikes by the Central Bank of Brazil from 2013 to 2015 resulted in a depreciation of real against the US dollar and that a sizable part of it can be explained by the shock to currency risk premium.

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Introduction

The presence of fiscal dominance can have profound implications for monetary policy. Fiscal dominance is widely understood as the state of the world in which inflation becomes a fiscal phenomenon.[1] Put differently, fiscal policy, not monetary policy, is the right instrument to control inflation.[2] The presence of fiscal dominance is usually measured by looking at quarterly data.[3] This paper proposes a novel approach to evaluate the presence of fiscal dominance by using daily reactions of the exchange rate to interest rate decisions by the central bank.

In particular, we build on the intuition advanced by Blanchard (2004) according to which a country is de facto in a fiscal dominance regime, if central bank-engineered increases in real interest rates result in depreciation rather than appreciation of the exchange rate and therefore in higher rather than lower inflation. The reason for this unintended reaction of the exchange rate is that the engineered increase in interest rate differential is not enough to offset a rise in currency risk premium caused by rising probability of default on government debt. By formulating the Blanchard (2004) model in terms of daily changes around central bank decisions, we are able to evaluate whether exchange rate reactions reveal the presence of fiscal dominance.

We apply our approach to Brazilian data and obtain two interesting results. First, we show that cumulative daily reactions of real/dollar exchange rate across tightening cycles by the Brazilian Central Bank (BCB) from 2002 until 2015 had a correct (negative) sign in four out of five cycles and a wrong (positive) sign i.e. towards a depreciation of real in the last tightening cycle from 2013 until 2015. Second, we find that the real depreciation during the last cycle can be explained primarily by rising risk premium driven by higher probability of sovereign default.

Although there are several related papers to ours, we are the first to study daily reactions of the exchange rate in order to gouge the degree of fiscal dominance. Baig, Kumar, Vasishatha & Zoli (2006) explore daily reactions of credit spreads, interest rates and exchange rates to news regarding fiscal policy and fiscal variables from several countries. They conclude that monetary policy efficacy is indeed

[1] See Loyo (1999).

[2] See Blanchard (2004).

[3] See for example Kumhof, Nunes & Yakadina (2010) among many others.

weaker with higher levels of overall and external pubic debt. Ersel, Tepav & Fatih (2007) show that Turkish lira depreciated when the Central Bank of Turkey raised interest rats in July 2001, but they focus their analysis on other ways to evaluate the presence of fiscal dominance in Turkey.

Regarding the case of Brazil, a number of papers argue that the country was in a fiscal dominance regime in the past. Loyo (1999) shows how a failure of fiscal backing for monetary policy can result in interest rates having no effect on inflation and motivates his model with a Brazilian experience in the late 1970s and early 1980s. Tanner & Ramos (2003) analyze the period from 1991 to 2000 and find that the response of primary budget deficits to liabilities of the Brazilian government is statistically insignificant, which should be observed under a fiscal dominance regime. Blanchard (2004) argues that the Brazilian economy around 2002 found itself in a situation in which increases in real interest rates would have seriously affected the fiscal position.

The paper starts by introducing the one-period model of Blanchard (2004) and explains how we decompose the movements of the exchange rate around central bank decisions. Section 2 introduces the dataset and explains how to estimate shocks to interest rate differential from interest rate futures. Lastly, section 3 applies our approach to Brazilian data.

1 Empirical set up

This section introduces the one-period model of Blanchard (2004) and derives the capital flow relation between the exchange rate, on one side, and interest rate differential and the probability of sovereign default on the other. In the second part of the section, we express the capital flow relation in terms of daily changes around central bank decisions.

1.1 One-period model of Blanchard (2004)

Let us suppose that there are three financial assets in the world economy: a risk-free domestic bond with the real rate of return in terms of domestic goods of r, a defaultable government bond in local currency (e.g. the Brazilian real) paying the real rate of return of r^R and a risk-free foreign bond denominated in foreign currency r^*. The expected real rate of return on the government bond in case of no default is assumed to be

$$(1-p)(1+r^R) = (1+r) + \theta p \tag{1}$$

where θ reflects the average risk aversion on the world market and p is the probability of default on government debt. If risk-averse foreign investors can choose between domestic and foreign government bonds, the capital flow into and from the domestic country can be defined as a function

$$CF = C\left((1-p)(1+r^R) - \frac{s'}{s}(1+r^*) - \theta^* p\right) \tag{2}$$

determined by expected returns on domestic and foreign bonds (expressed in terms of domestic goods) and an adjustment for risk, where $C' > 0$, s is the exchange rate (e.g. the amount of Brazilian reals for one US dollar), s' is the next-period exchange rate and θ^* is the risk aversion of foreign investors. Intuitively, the higher the return on domestic bonds, the lower the return on foreign bonds and the lower the risk compensation for holding domestic bonds, the larger the capital inflows.

Expressing the expected return on domestic bonds in terms of risk premium over a riskless rate and re-arranging the equation yields

$$CF = C\left((1+r) - \frac{s'}{s}(1+r^*) + (\theta - \theta^* p)\right)$$

If we assume that average risk aversion on the market is a proportion of foreign risk aversion:

$$\theta = \lambda\theta^*$$

where $\lambda \leq 1$, i.e. the degree of risk aversion among foreign investors is higher than the average risk aversion among domestic and foreign investors, we have

$$CF = C\left((1+r) - \frac{s'}{s}(1+r^*) - (1-\lambda)\theta^* p\right)$$

Finally, if net exports can be defined as a function of the real exchange rate

$$NX = N(s)$$

where $N' > 0$, then the sum of capital flows and net exports equals to zero in equilibrium

$$C\left((1+r) - \frac{s'}{s}(1+r^*) - (1-\lambda)\theta^* p\right) + N(s) = 0 \tag{3}$$

According to Blanchard (2004), a good semi-log approximation to equation (3) is given by

$$log(s) = a - b\left(r - r^{\$}\right) + c\left(p\theta^{\$}\right) \tag{4}$$

where a, b and c are reduced-form parameters. In other words, the real exchange rate is a decreasing function of the interest rate differential and an increasing function of the risk premium, which is in turn a product of default probability on domestic debt and the risk aversion of foreign investors.

A note regarding the probability of default is warranted. Blanchard (2004) considers the p to be an endogenous function of the level of domestic debt, the degree of risk aversion and the proportion of dollar debt in total government debt in order to illustrate the equilibria in which increasing real interest rate r can result in higher probability of default and therefore a depreciation of the domestic currency. We remain agnostic about what determines the probability of default and ask instead how individual policy decisions affect the perceived probability of default and in turn the exchange rate and inflation.

1.2 Capital flow relation around policy decisions

Equation (4) represents a testable specification we are going to take to the data. Let us write the equation in terms of daily differences around the central bank decisions:

$$\Delta s_d = \beta \Delta \left(r_d - r_d^{\$} \right) + \gamma \Delta \left(p_d \theta_d^{\$} \right) \tag{5}$$

where Δs_d is a one-day change in the exchange rate on the policy action day, the first term on the right hand side can be though of as the shock to the interest rate differential, the second term is the shock to the foreign exchange risk premium. We arbitrarily split the expected interest rate differential to "target rate" differential and "forward guidance" differential and estimate the following linear regression

$$\Delta s_d = \beta^T \Delta \left(T_d - T_d^{\$} \right) + \beta^G \Delta \left(G_d - G_d^{\$} \right) + \gamma \Delta \left(p_d \theta_d^{\$} \right) + \varepsilon_d \tag{6}$$

where T and $T^{\$}$ represent the unexpected change of the respective target rates in the two countries[4] and G and $G^{\$}$ are unexpected changes in forward guidance of the two central banks.[5]

The transmission mechanism of monetary policy shocks to macroeconomic variables can change over time. Beside using OLS, we also estimate a time-varying coefficient version of the equation 6. Let us express the equation in the state-space form

$$\begin{aligned} \Delta s_d &= \left[\begin{array}{ccc} \Delta \left(T_d - T_d^{\$} \right) & \Delta \left(G_d - G_d^{\$} \right) & \Delta \left(p_d \theta_d^{\$} \right) \end{array} \right] \mathbf{B_d} + \varepsilon_d \\ \mathbf{B_d} &= \mathbf{I} \mathbf{B_{d-1}} + \xi_d \end{aligned} \tag{7}$$

where $\mathbf{B_d}$ is a 3×1 vector of time-varying parameters β_d^T, β_d^G and γ_d, $\mathbf{I}$ is the identity matrix, $\varepsilon_d \sim N(0, \sigma_\varepsilon)$, and $\xi_d \sim N(0, \sigma_\xi)$. Note that the coefficients are assumed to follow a random walk without drift.

[4] As proposed by Kuttner (2000) and explored subsequently in a variety of studies.

[5] Along the lines of Gürkaynak, Sack & Swanson (2005).

2 Data

In this section, we introduce the dataset we used and explain how we estimate interest rate differentials from interest rate futures.

2.1 Data for Brazil

We use daily data on the exchange rate of Brazilian real against the US dollar, sovereign CDS spread on Brazilian government debt and interest rate futures.[6] Regarding interest rate futures, we use the so-called DI futures for Brazil and Eurodollar futures for the US. The DI futures are written on the DI (Portuguese: *Deposito Interbancario*) rate, which is an overnight interbank borrowing rate in Brazil. DI futures are the most popular market-based forecasts for the BCB's policy rate, the Selic rate.[7] On the US side, the Eurodollar futures are written on the 3-month US dollar Libor and shown to have significant predictive power of future the Fed funds target rate.[8].

Coming to the BCB policy actions, we consider all the decisions made by the Monetary Policy Committee (Copom, Portuguese: *Comitê de Política Monetária*) that resulted in a change of the Selic target rate. The reason for looking at those particular decisions only and not including the decisions to leave the Selic unchanged is that we are mainly interested in the effects of target rate changes on the exchange rate. In our empirical specification, we do include longer-term interest rate expectations in order to account for the elements of forward guidance in the policy statements.

Since the BCB introduced inflation-targeting in July 1999 until the end of 2015, there were in total 100 decisions made by the Copom to either increase or decrease the Selic target rate. However, the CDS data start only in late 2001 - beginning of 2002. Therefore, our sample starts on January 2, 2002 and consists of 87 policy actions by the Copom: 42 decisions to hike the Selic rate and 45 decisions to decrease that rate.

[6]The data are downloaded from Bloomberg and market close hours are set to 18:00 London time, i.e. 16:00 hours Brasilia time.

[7]See Costa, Nespoli & Robitaille (2007).

[8]See for example Cochrane & Piazzesi (2002)

Copom usually communicates it's decisions after the second day of the meeting and the press release is published in the evening on the second day. Therefore, the policy action day d in equation (5) is basically one day after the Copom meeting and that is the day when the market is most likely pricing-in the new information. On several occasions, Copom statement was published a day before/after a public holiday. We therefore consider 2-day differences for these policy actions.[9]

2.2 Estimating interest rate differential from futures

We identify monetary policy shocks to real/dollar exchange rate using changes in interest rate differential implied by interest rate futures around the Copom decisions. The idea that futures quotes around monetary policy announcements could be used to identify a policy shock was proposed by Kuttner (2000).[10] In this section, we extend the idea to interest rate differentials where futures contracts traded on different exchanges can in principle have different settlement months.

As a matter of fact, Eurodollar futures are settled in March, June, September and December, whereas the most liquid futures contracts on the Brazilian side are cash-settled in January, April, July and October. In order to overcome the settlement date mismatch, we estimate futures rates with "constant maturity" by fitting a Nelson-Siegel-Svensson (NSS) forward curve to observed futures quotes. Then, we use NSS parameter estimates to back out constant-maturity (e.g. 3-month) futures rates from the raw data.

In particular, Svensson (1994) assumes that the instantaneous forward rate is a function of a simple polynomial. If $f(t,t+m)$ is an instantaneous forward rate traded at time t with time to settlement m, the NSS forward rate function reads

$$f(t,t+m) = \delta_0 + \delta_1 exp\left(\frac{m}{\tau_1}\right) + \delta_2 \frac{m}{\tau_1} exp\left(\frac{m}{\tau_1}\right) + \delta_3 \frac{m}{\tau_3} exp\left(\frac{m}{\tau_2}\right)$$

where δ_i for $i = \{0,1,2,3\}$ and τ_k for $k = \{1,2\}$ are model parameters. The first term on the right-hand side "affects" all the elements of the forward curve equally and

[9] In particular: June 20, 2003, April 22, 2005, January 25, 2007, June 8, 2007, June 12, 2009, April 25, 2011, May 31, 2013 and June 5, 2015.

[10] See also Bernanke & Kuttner (2005) and Gürkaynak et al. (2005) among many others.

therefore it is usually referred to as the level factor. The second term is monotonically decreasing towards zero as a function of m. The literature refers to it as the slope factor, because it only affects one side of the curve. The last two terms generate a hump-shaped forward curve and can be interpreted as the curvature factors. We estimate the models' parameters by minimizing the sum of squared pricing errors. There are eight raw futures quotes per day and six parameters to estimate in the NSS model.[11]

3 Results

This section reports cumulative reactions of real/dollar exchange rate across the tightening cycles in Brazil from 2002 until 2015. It also estimates the average sensitivities as well as the time-varying sensitivities of the exchange rate to the shocks in the interest rate differential and the currency risk premium. The third part of the section looks at the decomposition of the exchange rate reactions to BCB decisions.

3.1 Cumulative reactions of real/dollar

Unexpected increase in policy rates should result in appreciation of the currency according to uncovered interest rate parity (UIRP).[12] As a matter of fact, the Table 1 shows that four out of five tightening cycles by the BCB resulted in a stronger real – a lower real/dollar exchange rate. However, we observe an opposite reaction of the exchange rate to BCB tightening in the last policy cycle that started in 2013. The cumulative daily changes of real/dollar are positive across various "closing times" and even for the exchange rate expectations published by the BCB. Both the spot currency market and the economists surveyed by the BCB likely perceived the Copom decisions to tighten policy rates in the last cycle as those making real less, not more, attractive as the UIRP would suggest.

[11]We use a downhill simplex method for estimation, letting the algorithm calculate the search direction in an iterative way.

[12]See for example McCallum (1994).

3.2 Average sensitivities

We estimate the equation (6) by using OLS and obtain the following coefficient estimates

$$\Delta s_d = \underset{(0.93)}{-0.96}\Delta\left(T_d - T_d^{\$}\right) + \underset{(1.64)}{0.57}\Delta\left(G_d - G_d^{\$}\right) + \underset{(0.44)}{1.60}\Delta\left(p_d\theta_d^{\$}\right) \quad (8)$$

$$\sigma_\varepsilon = 3.79 \quad R^2 = 0.10 \quad DW = 2.10$$

where T and $T^{\$}$ are the 2-month DI futures rate and the 2-month Eurodollar futures rate, respectively, G and $G^{\$}$ are the 1-year DI and Eurodollar futures rates, p is the 5-year CDS spread i.e. a function of the probability of sovereign default, θ is the Baa spread, and $\varepsilon_d \sim N(0, \sigma_\varepsilon)$. The standard errors are reported in brackets.[13]

Changes in the target rate differential negatively affect the exchange rate, i.e. the higher the unexpected change in the Selic rate with respect to that of the Fed Funds target rate, the stronger the real and vice versa. Unfortunately, the coefficient is insignificant. The guidance term is also insignificant and has even a wrong sign.[14] More importantly, the coefficient in front of the risk premium is statistically significant and has the correct sign, i.e. an increase in risk aversion or the probability of default is related to a depreciation of real relative to the dollar.

3.3 Time-varying sensitivities

We estimate the state-space model (7) using Bayesian estimation. In particular, we use the Gibbs sampler. The starting values for the coefficients in $\mathbf{B_d}$ as well as the parameters of the prior distribution of σ_ε and σ_ξ are set using the OLS estimates from the equation (8). Following the Carter & Kohn (1994) algorithm, we sample $\mathbf{B_d}$ from an appropriate conditional posterior distribution. Conditional

[13]We treat the interpolated futures rates as observed in the same way the constant maturity zero-coupon yields are treated in the literature.

[14]Glick & Leduc (2015) report similar findings for the FOMC announcements and several currencies against the US dollar.

on $\mathbf{B_d}$, σ_ε and σ_ξ are sampled from an inverse Wishart distribution.[15] Figure 1 reports the estimated coefficients for each Copom announcement.

Interestingly, the coefficient for the target rate differential becomes significant towards the end of the sample. One percentage point of unexpected increase (drop) in the target differential is related to an appreciation (depreciation) of 10 cents of real against the dollar. The coefficient in front of the risk premium proxy increases multiple times towards the end of the sample from the average of 1.60 reported in the equation (8).

3.4 Decomposing the exchange rate reactions

We use the estimates of the state-space model (7) to decompose the real/dollar reactions to the Copom announcements across the three shocks: the shock to target rate differential, the shock to forward guidance and the shock to the risk premium. Figure 2 reports the main findings.

The cumulative daily reaction of the real/dollar rate in the last hiking cycle is positive and in the direction of real depreciation instead of appreciation (see also Table 1). Most importantly, the figure shows that the reaction is primarily driven by the risk premium shock and that the "unexpectedly hawkish" Copom decisions were systematically insufficient to offset the higher probability of default and/or higher risk aversion priced after the announcement.

4 Conclusion

We propose a simple empirical set up that uses daily data around central bank decisions to evaluate the presence of fiscal dominance. We apply this approach to Brazilian data and find that the exchange rate reactions to BCB decisions in the tightening cycle from 2013 to 2015 are consistent with the presence of fiscal dominance. An open question remains whether the cumulative depreciation of the real during that period produced unintended effects on inflation and inflation expectations.

[15] We run the sampler for 5,000 times and discard the first 3,000 iterations as the burn-in period.

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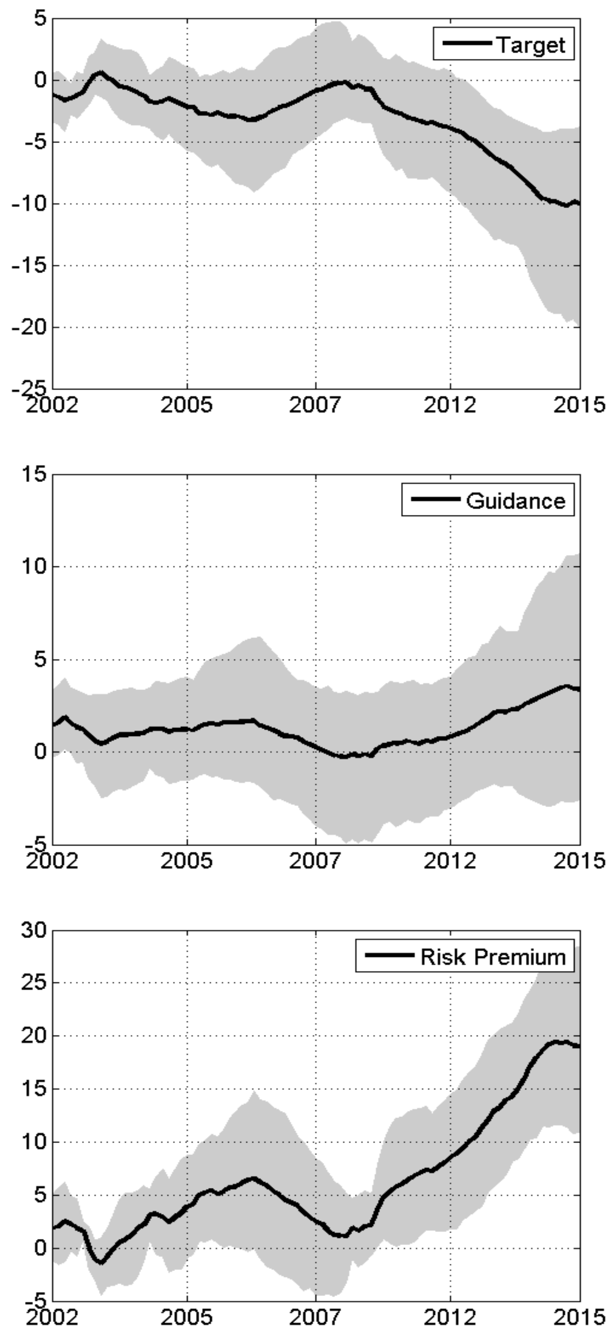
5 Tables and Figures

Table 1: **Cumulative changes in real/dollar across tightening cycles**. Table reports the cumulative change in the Selic target rate (column Δ Selic) across five tightening cycles and cumulative daily changes in the exchange rate in pips around the respective Copom announcements. The real/dollar rates are snap-shots at 18:00 hours London time (16:00 Brasilia time), 17:00 hours New York time (20:00 Brasilia time) and 22:00 hours Tokyo time (09:00 Brasilia time) available on Bloomberg, average daily rates calculated by the BCB (column BCB) and daily real/dollar expectations "for the current year" (column Exp) published by the BCB.

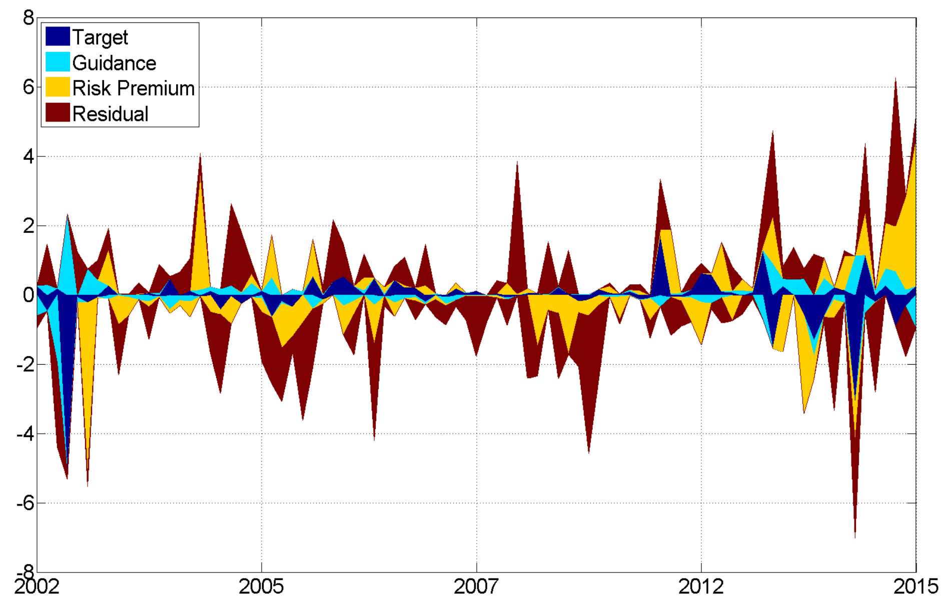
Cycle	Δ Selic	16:00	20:00	09:00	BCB	Exp
2002-2003	850	-410	-470	-470	-514	300
2004-2005	375	-710	-991	-995	-1379	-300
2008-2008	250	285	122	-306	188	0
2010-2011	375	-1028	-1028	578	-705	-300
2013-2015	700	785	785	1953	2088	500

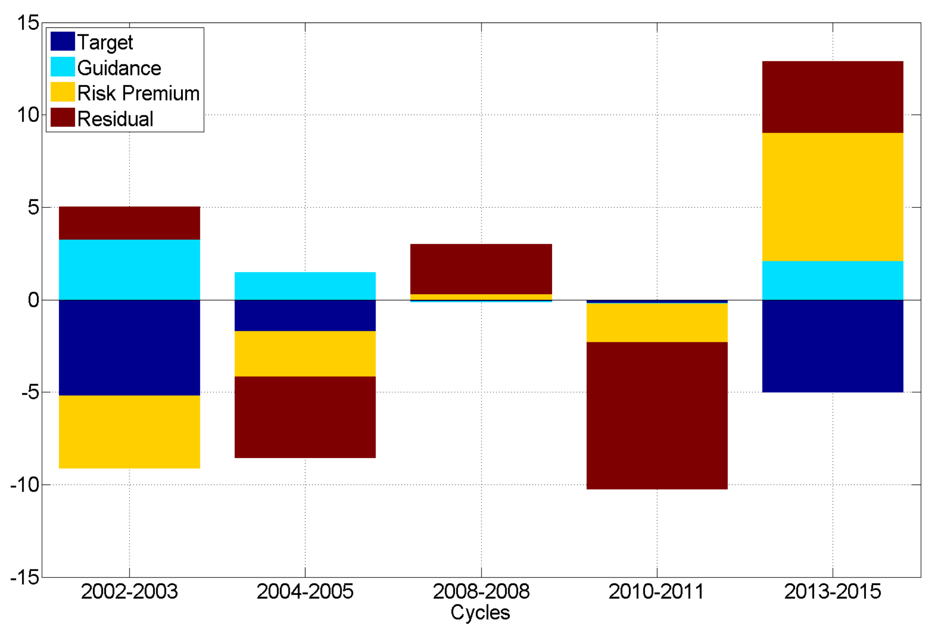
Figure 1: **Time-varying parameter estimates.** The figure reports the estimated parameters β_d^T (upper panel), β_d^G (mid-panel) and γ_d (lower panel) across Copom announcements of the Selic rate changes (x-axis) together with a 90 percent credible interval.



Source: Authors' calculations

Figure 2: **Decomposing exchange rate reactions.** The figure reports the estimated decomposition of daily reactions of the real/dollar exchange rate to individual Copom announcements (upper panel) as well as cumulative changes of the real/dollar and its components across tightening cycles (lower panel).





Source: Authors' calculations