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Structural changes in exchange rate regimes in Brazil

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Abstract

Following a dramatic breakdown of a managed floating regime, Brazil adopted a framework for policy consisting of inflation targeting and floating exchange rates. The country's commitment to this arrangement, however, is often put to dispute. In this paper we revisit the issue of whether Brazil has truly accepted to let its currency float, taking use of cross-currency linear regression models complemented by inferential techniques for evaluating the stability of exchange rate regimes. The results found suggest that Brazil does seem to have shifted towards greater exchange rate flexibility after the abandonment of its dollar-peg. However, after the adoption of inflation targeting the degree of exchange rate flexibility seems to have reduced a little.

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1. Introduction

The adoption of a floating exchange rate regime in Brazil can be best described as an unplanned policy change, as opposed to a conscious shift conducted by decided monetary authorities (see e.g. Nogueira Jr & León-Ledesma 2009). The country had pegged its nominal exchange rate to the dollar in 1995 as means to achieving price stability. This strategy proved itself able to bring down inflation rates in Brazil to international levels by 1998, but at the same time deepened the country's external weaknesses. As the market lost confidence in the economy the cost of maintaining the exchange rate peg increased dramatically, leaving the central bank with no choice but to announce that it would let the currency float, at the beginning of 1999.

This drastic regime change led to some disbelief regarding the country's true commitment to the floating exchange rate. In this sense, the literature has shown that the *de jure* exchange rate regime in a country is very often different from the *de facto* regime (see e.g. Reinhart & Rogoff 2004). Moreover, it has been argued that Brazil, among other emerging markets that adopted inflation targeting in the late-1990s, have suffered from "fear of floating" (Calvo & Reinhart 2002), with the central bank constantly intervening in the foreign exchange market[1]. This debate has resumed with some additional strength in the past few years, after the central bank started buying dollars and accumulating foreign international reserves to unprecedented levels.

In order to investigate whether a *de facto* change in exchange rate regime has occurred in Brazil, as well as of checking the stability of such change, we employ the methodology developed by Zeiles, Shah & Patnaik (2010). Their strategy is based on traditional cross-currencies exchange rates linear regressions, as proposed by Frankel & Wei (1994), but complemented by inferential techniques for evaluating regime stability.

Our results suggest that Brazil has indeed faced a regime shift from a fixed exchange rate to a much freer regime in early 1999. This initial shift, however, was followed by a second regime change, which somewhat reduced the exchange rate flexibility. This second shift after the abandonment of the dollar-peg seems to be linked to the adoption of inflation targeting. This is in line, at least to some extent, with Calvo's (2001) critique that inflation targeting regimes in emerging market countries are very often associated to exchange rate interventions[2]. Although the results do not suggest that Brazil is following a peg, it is clear that the adoption of inflation targeting was followed by a decrease in exchange rate flexibility.

The reminder of the paper is structured as follows: Section 2 describes the methodology and the data used in our estimations; Section 3 presents the results; and finally, Section 4 concludes.

2. Methodology

In order to investigate the occurrence of a *de facto* change in exchange rate regime in Brazil we apply the methodology proposed by Zeiles, Shah & Patnaik (2010). Consider the following model:

$$y_i = x_i{'}\beta + u_i \quad (i = 1,\ldots, \text{n}), \tag{1}$$

[1] Ball & Reyes (2008), for e.g., include Brazil in their list of countries that "disguise" their exchange rate objectives within an inflation targeting framework.

[2] Calvo (2001) argued that adopting an inflation targeting regime is equivalent to pegging a currency to a basket of goods. If the basket contains a large proportion of tradable goods, the regime will eventually develop into an exchange rate peg.

where y_i is a vector of dependent variables, which in this case refers to returns of the target currency with respect to a given currency[3]. The vector of independent variables x_i includes the returns for a basket of currencies, normalized in a similar way of the dependent variable in terms of a given currency, plus a constant.

The model yields the following alternatives as we can see in Table 1:

Table 1
Parameter´s values and model characteristics

***De facto* exchange rate regime**	**Characteristics of the model**
Fixed	One element of β is 1 and the others are 0, with the variance $\sigma^2 = 0$.
Pegged against one currency	One element of β is close to 1 and the others are close to 0, with the variance σ^2 taking small values.
Pegged against a basket of currencies	The β coefficients correspond to the weights of the basket, with the variance σ^2 taking small values.
Floating	The β coefficients reflect the traditional effects of current and capital accounts, with the variance σ^2 taking high values.

As argued by Zeileis, Shah & Patnaik (2010), the traditional methods for identifying structural breaks are based on OLS estimations, and hence σ^2 is treated as a parameter of the model. This limitation is overcome by the authors by applying Perron`s (2003) (quasi-)likelihood models. The R^2 is also an important aspect for deciding which regime the country is truly following, with low values associated with freer regimes.

The analysis of structural breaks is conducted by means of M-fluctuation tests. Such tests are based on the analysis of first order conditions of minimization problems of the negative of the log-likelihood. As the first order condition must be equal to zero so as we may have a minimum for the function, deviations of the estimations may represent instability of the parameters. Nonetheless, this test may suffer from lower power if either multiple structural breaks are present, or if the null hypothesis is a random walk, in which case the authors suggest the Nyblom-Hansen, S_{CvM} or the Andrews, S_{supLM} tests[4].

3. Results

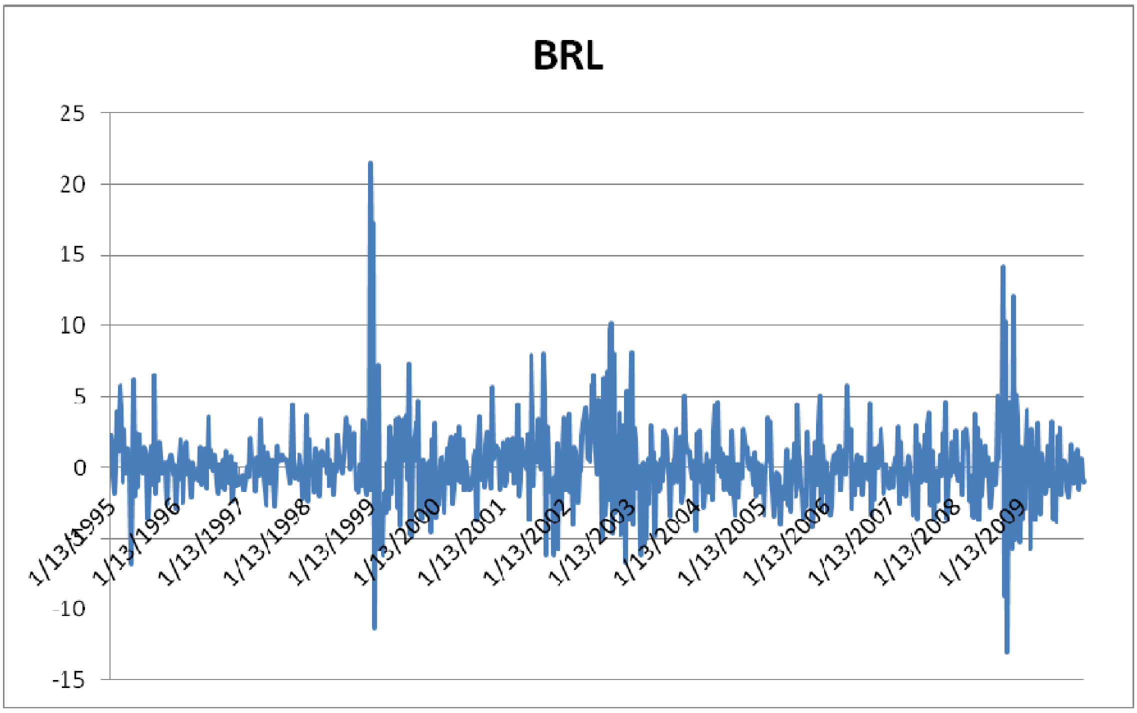
In our estimations we use weekly returns for the Brazilian currency over the period 01-01-1995 to 01-01-2010[5]. The data is shown in the Graph 1.

[3] The return is computed as the percentage change of the exchange rate with respect to a given numeraire (that is, $100*(\log p_t - \log p_{t-1})$ where p_t is the price of a currency in terms of a numeraire). Zeileis, Shah & Patnaik (2010) argue that the results are not sensitive to the choice of numeraire. We thus follow their approach and use the Swiss Franc (CHF) as the numeraire currency.

[4] See the Appendix for a deeper discussion on the methodology.

[5] The data used comes from: http://www.federalreserve.gov/releases/h10/Hist/. We used weekly data to maintain the comparability of our results with those obtained by Zeileis, Shah & Patnaik (2010). These authors also justify the choice for weekly frequency on the reduction of noise and also on computational burdening.

Graph 1
Daily returns for the Brazilian currency - 01-01-1995 to 01-01-2010



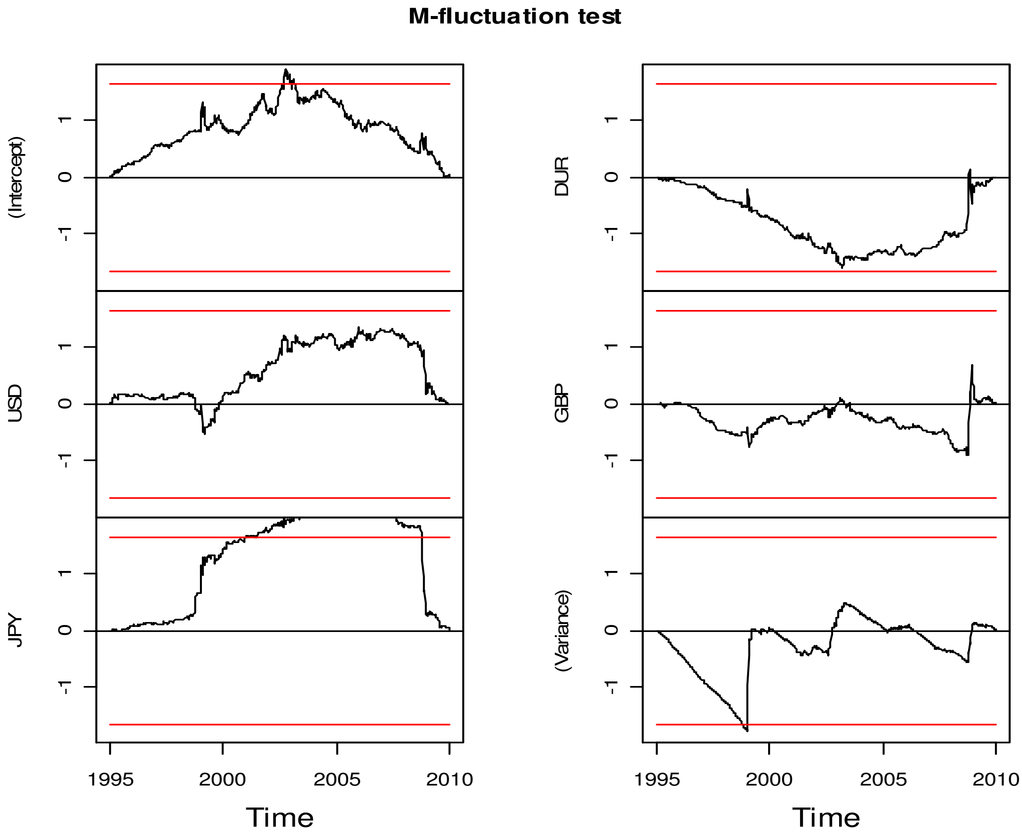
A trivial visual inspection of the data may suggest that there is indeed at least one break in exchange rate policy over the period, around early 1999. To shed some light on the issue we start estimating the model (1) for our full sample. The basket of currencies used in our estimation consists of: USD (US dollars), JPY (Japanese Yen), DUR (the Euro after its implementation, and the German Marco, DEM, before), and GBP (British pound). As Zeiles, Shah & Patnaik (2010) pointed out, including more currencies to the estimation does not necessarily increase the quality of the results, so it is a good practice to include only the leading currencies in the world.

Table 2
Estimation results – full sample

	Coefficients	Std. Error	T Estat	Prob.
Constant	0.0826	0.08089	1.066	0.28659
USD	0.64094	0.07622	8.410	0.00000
JPY	-0.15015	0.05364	-2.799	0.00525
DUR	0.76810	0.15339	5.007	0.00000
GBP	0.40863	0.07980	5.121	0.00000
R^2	0.3284			

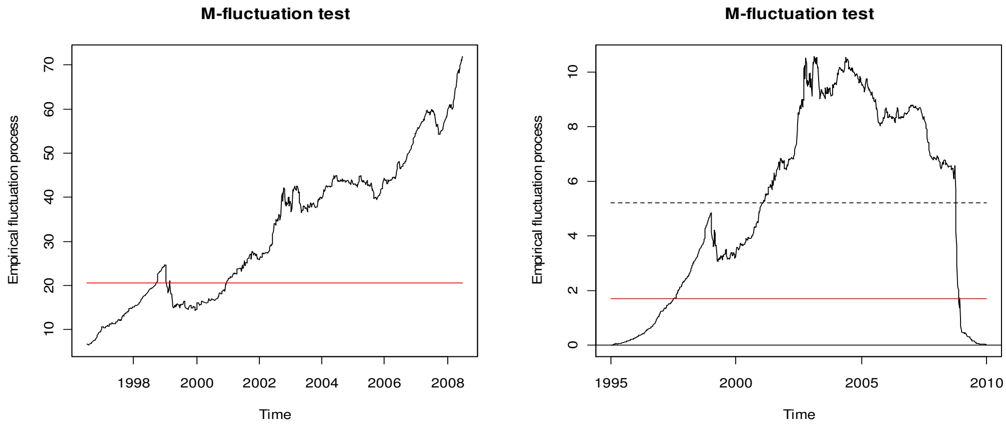
Considering the entire sample the results showed in Table 2 suggest the existence of a regime close to free floating, with a low R^2. Nonetheless, the estimated coefficients may not represent a stable regime, and structural breaks may be present in the data. In particular, the central bank has made two announcements of regime shifts that may have had an effective impact on the exchange rates. The first one was the abandonment of the dollar-peg (January 1999), and the second one was the adoption of inflation targeting (June 1999). The monitoring of breaks is shown in Figure 1.

Figure 1



The graphs in Figure 1 show that the intercept, the return of the Yen, and the variance, all exceed the 5% bounds, suggesting the existence of structural breaks. This result is reinforced by the double maximum tests. For the first test we find S_{CvM} = 5,2143, with a p-value of 0,005, and for the second test we find S_{supLM} = 2,2584, with a p-value of 0,0004456. In both cases the results suggest the existence of multiple breaks. In Figure 2 we show the graphs for both tests.

Figure 2



Following Zeileis, Shah & Patnaik (2010) we conducted a dating procedure for m=1, …, 10, with a minimum segment size of 20 observations. The results are shown in the Graph 2. Under the NLL (negative log-likelihood) we observe 3 breaks. The LWZ decreases quickly and also suggests 3 breaks. The breaking points, as well as their confidence intervals, are shown below with some comments on their meanings.

a) 08/18/1995 - **08/25/1995** - 11/10/1995: in October 1995 the central bank announced it would follow a crawling-peg, with monthly devaluations of 0.6% with respect to the dollar.
b) 10/09/1998 – **01/08/1999** – 01/15/1999: in January 1999 the central bank announced the abandonment of the dollar-peg.
c) 05/21/1999 – **05/28/1999** – 08/27/1999: in June 1999 the central bank announced it would pursue an official inflation target.

Graph 2

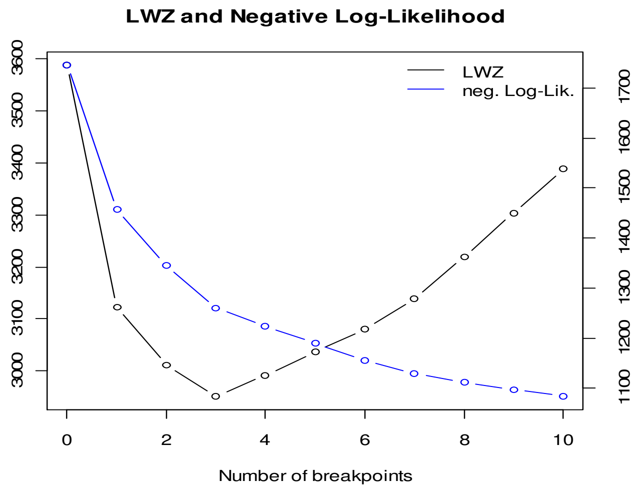


Table 3
Estimation results – sub-samples

Segments	β_0	βUSD	βJPY	βDUR	βGBP	σ	R^2
01/13/1995 25/08/1995	**0.3264** (*)	**0.9551** (***)	-0.1178	0.2704	0.1899	0.8788	0.8981
01/09/1995 08/01/1999	**0.1396** (***)	**1.0037** (***)	0.0032	-0.0123	0.0117	0.1809	0.9847
15/01/1999 28/05/1999	1.5465	0.3059	0.9604	0.6639	0.1756	8.679	0.0831
04/06/1999 01/01/2010	-0.0151	**0.7271** (***)	**-0.31932** (***)	**0.8298** (***)	**0.4660** (***)	2.147	0.3835

Note: Bold coefficients are significant at the 10%(*), 5%(**) or 1%(***) level.

The results of the estimations by segments are shown in Table 3. In summary, the results suggest that Brazil faced a transition from a pegged exchange rate to a floating regime. In the first two segments it is clear that the central bank was following a peg, with the betas for the dollar close to one, with high R^2. The third segment corresponds to a period of great exchange rate flexibility, with betas not statistically different from zero, high σ, and a low R^2. This segment is associated with the period immediately after the official adoption of a floating exchange rate. However, the results suggest the existence of another break, which corresponds to the period of adoption of inflation targeting. This fourth segment suggests that Brazil may have entered a grey-area between a floating regime and a peg to a basket of currencies (with a low σ). This result may be related to fear of floating practices that seem to be common among emerging markets under inflation targeting regimes (see, for e.g., Calvo 2001; Ball & Reyes 2008).

4. Conclusion

In this paper we have applied a formal inferential framework for analyzing the stability of the Brazilian exchange rate regime from 1995 to 2010. The results confirm that Brazil has indeed moved away from a pegged exchange rate towards a freer regime. Nevertheless, the degree of exchange rate flexibility seems to have decreased after the adoption of inflation targeting, suggesting some degree of exchange rate smoothing by the central bank.

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Appendix[6]

Zeileis' methodology to structural change can be summarized in three general steps[7]:

1. Estimate the model that will be used in the structural change testing;

2. Find the epf (empirical fluctuation process) from M-estimation scores;

3. Build a scalar test statistic from the epf, so there is a structural change under a pre-determined probability level.

One important point here is to construct the M-estimation score. Basically, the author's approach is to test the null hypothesis that parameters are constant over the full sample period. In case of time series, the constancy is considered "over the time", but the test could be generalized to other dimensions.

The M-estimation score function is such that it has zero expectation (mean) under the null hypothesis. In order to look for instabilities, it's useful to calculate the cumulative sum of these scores such that:

$$\sum_{i=1}^{n} \psi\left(y_i, x_i, \hat{\theta}\right),$$

where $\psi(.)$ is the M-estimation score function, y_i and x_i are, respectively, the vector of the dependent variable and the matrix of the dependent variables used in the initial regression, and $\hat{\theta}$ is the estimated vector of the parameters.

Zeileis (2005) define the cumulative score process formally as:

$$W_n(t,\theta) = \frac{1}{\sqrt{n}} \sum_{i=1}^{[nt]} \psi\left(y_i, x_i, \theta\right), \ efp(t) = W_n(t,\theta)\sqrt{\hat{J}} \ ,$$

where efp is the *empirical fluctuation process* and $\hat{J}$ is an estimate of the variance-covariance matrix of the scores. If this matrix has evidence of heteroskedasticity and/or autocorrelation, it can be estimated using consistent estimators like HC and HAC.
In order to obtain a statistic test from the efp(.) process, it´s enough to find a functional λ such that λefp(.) will be this statistic. However, there are several options for λ(.). Zeileis discuss four main statistics: the double maximum statistic - S_{dmax}- the Cramer-von Mises statistic - S_{CvM} -, the moving sum statistic - S_{MOSUM} – and the supremum of LM - S_{supLM}. Below is a short view of each of them.

[6] This Appendix is heavily based on Zeileis (2006) and Zeileis, Shah & Patnaik (2010).
[7] One advantage of this approach is to allow to test for the stability with the estimated β's and also the estimated σ^2.

Table A.1 – Functionals for efp

Statistics	
$S_{d\max} = \sup_{t\in[0,1]} \lVert efp(t) \rVert_\infty$	Useful for exploratory view about the timing of the break. Low power under the alternative of multiple breaks or random walk Perform better if only one parameter changes
$S_{CvM} = \frac{1}{n}\sum_{i=1}^{n} \lVert efp(i/n) \rVert_2^2$	Based on maximum likelihood scores, powerful against the alternative of multiple breaks or random walk. Perform better if several or all parameters change at the same time
$S_{MOSUM} = \sup_{t\in[0,1-h]} \lVert efp(t+h) - efp(t) \rVert_\infty$	Powerful against the alternative of multiple breaks or random walk. Perform better if only one parameter changes
$S_{\sup LM} = \sup_{t\in[\pi,,1-\pi]} \frac{\lVert efp(t) \rVert_2^2}{t(1-t)}$	Useful to test for a single abrupt change of unknown timing. Perform better if several or all parameters change at the same time

Specifically, in the case of the S_{supLM} and the S_{CvM} statistics, both perform better when several parameters of the parameter vector change at the same time. However, the latter perform better under the alternative of multiple breaks or a random walk alternative. These two tests were used in this paper because we didn´t have any *a priori* information about the number of breaks or the number of parameters that could be experiencing instability.