Short and long-run relations between capital netflows and the differential of American and Brazilian interest rates

Alan M. M. Leal

PhD student in Economics – Faculdade de Economia, Administração e Contabilidade (FEA)/

University of São Paulo. E-mail: alanleal@usp.br

Stefan W. D'Amato

PhD candidate in Economics – Centro de Desenvolvimento e Planejamento Regional (CEDEPLAR)

Federal University of Minas Gerais, Belo Horizonte, Brazil

Igor V. M. Viveiros

Associate professor - Centro de Desenvolvimento e Planejamento Regional (CEDEPLAR)

Federal University of Minas Gerais, Belo Horizonte, Brazil

Abstract

This work aims at investigating the possible cointegration of the difference between the Brazilian and American real interest rates and the Brazilian capital netflows. Our main methodology is that of cointegrating processes, using spectral analysis. A cointegration process in the frequency domain allows us to test whether two series are of the same order of integration, even if this order is not 1, and given the lower order of the residuals of one series over the other, to affirm that a couple of series are cointegrated. We use those tests and we find that there is indeed cointegration between these two series and they also move similarly in the short-run.

Key-words: Capital netflows, interest rates, cointegration, spectral analysis.

Resumo

Este trabalho almeja investigar a possível cointegração da diferença das taxas de juros reais brasileira e americana e os fluxos líquidos para o Brasil. Nossa metodologia principal é o processo de cointegração, utilizando a análise espectral. Um processo de cointegração no domínio da frequência nos permite testar se duas séries têm a mesma ordem de integração, mesmo que essa ordem não seja unitária e, além disso, dada a menor ordem dos resíduos de uma série sobre a outra, confirmar que essas séries são cointegradas. Nós usamos esses testes e encontramos que há de fato cointegração entre essas duas séries e que elas se movem semelhantemente no curto prazo.

Palavras-chave: Fluxo líquido de capitais, taxas de juros, cointegração, análise espectral.

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1. INTRODUCTION

Capital flows are an important mechanism of equalization of returns among countries. According to Grubel [1968], a country can have some capital flows due to the difference in its returns and a bigger endowment of capital. Therefore, capital in- flows or outflows can serve as an investment source, therefore as a growth inducer. At the same time, their absence can serve as crisis catalysis.

According to Koepke [2019], it is usual to consider the determinants of capital flows as divided into those internal and global to a country, respectively, pull and push factors. Pull factors are usually divided into internal return indicators, risk indicators, and output growth. Push factors, on the other hand, can be divided into mature economy return indicators, mature economy risk indicators, and mature economy output growth.

There are many studies analyzing the causes of capital flows. We list them briefly here, expanding on them in their proper section. De Vita and Kyaw [2008] find that an external negative shock on American output reduces the capital flows to the countries analyzed in their study, which are Brazil, Korea, Mexico, Philippines, and South Africa. Byrne and Fiess [2011], for example, find that the American long-run interest rate is more important in determining capital flows to developing countries than the American short-run interest rates. Fratzscher [2012] find that before the Global Financial Crisis (GFC) of 2008, global factors were more important in determining the capital flows, while after the GFC, that changed, with pull factors, such as institutions and macroeconomic fundamentals being more important in determining such flows. This paper aims at answering the following question: how the differential of Brazilian and American interest rates affect the net capital flows to Brazil in different periods. We answer this question by employing the spectral analysis of cointegration on the series of net capital flows to Brazil and the differential of interest rates.

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We innovate in this paper in expanding what usually is considered as a sign of cointegration. In general, cointegration exists when two series are both non-stationary and then the residuals of a regression of one against the other are stationary. The spectral analysis augments this possibility. It considers that a cointegration relation happens when two series are of the same fractionary order of integration, statistically speaking, and the residuals of the projection of a series over another has an order of integration statistically speaking lower than two original series. So, using spectral analysis to analyze cointegration allows us to study relations amongst two series that would not be otherwise captured by a simple unit root methodology.

Besides this Introduction, this paper is divided into a literature review, Data Analysis, Methodology, results, and final remarks.

2. LITERATURE REVIEW

Now we briefly review the literature available on net capital flows. There are some seminal works on the net capital flows, such as Calvo et al. [1993]. This author studies the determinants of net capital flows to Latin America. They conclude that push factors are more important in determining net capital flows than pull factors. That is shown by the fact that after the liberalization of Latin American countries' markets, the flows have not changed much, rising alongside the outflows of developed markets only. Besides, recession in the developed countries and the reduction of their interest rates contributed to raising the capital flows to Latin America.

Another seminal work was Fernandez-Arias [1996], in which they analyzed the determinants of several private capital inflows in average income countries, according to the push-pull theory. They estimated an OLS for developing countries to accomplish this aim. The results show that capital flows stability is susceptible to external factors, even when there is an increase in a country's credibility. Furthermore, improvements in credit's ability of a country is a significant variable in explaining investors' behavior and the increase of capital inflows in average income countries, especially through the international interest rates.

Taylor and Sarno [1997] study pull and push factors that affect capital flows, bond flows, and equity flows, in the case of flows to Latin America and Asia. Using the models of cointegration, Johansen method, and Seemingly Unrelated Regression, they conclude that changes in the bonds flow seem to be more correlated with global factors (push factors) than domestic factors (pull factors), while the equity flows are more susceptible to specific factors, i. e., pull factors. Moreover, we have that capital flows to Latin America countries are as susceptible to interest rates as Asian countries, however, they are less sensible to other factors. Finally, changes in the American interest rates are the most import determinant in the short-run movements of bonds flows to developing countries.

Cardoso and Goldfajn [1998] analyzes the relationship between capital controls and flows to Brazil, through Ordinary Least Squares (OLS) and Vector Autoregressive (VAR) models. The authors correct their models with possible endogeneity between the capital flows and their controls. They verify that capital controls effectively affect the flow, in a way that these controls change not only the flow size but also their composition. Besides, the authors emphasize that the foreign interest rates are the principal determinant of capital flows to Brazil. Moreover, Cardoso and Goldfajn [1998] find that the capital controls matter only in the short-run, being neutral in the long-run.

Montiel and Reinhart [1999] aiming at evaluating the impact of short-run and long-run policies on the dynamics of capital flows, analyzed the relationship between the volume and share of portfolio flows in the domestic market (short-run) and investigated the effects of the interaction of capital account and monetary policy (long-run). Using panel methods, they found that the combination of limited flexibilization of exchange rate policies, strong sterilized intervention, and low capital inflows controls stimulated emerging Asia. Therefore, those policies can raise the capital flows and the composition of foreign direct investment (FDI) to the short-run components of the capital account.

Dasgupta and Ratha [2000] study the factors that drive several types of investments of capital flows to developing countries and the reactions to loans of official capital flows, using the panel data methods. The results show that private portfolio tends to increase due to the current account deficit, FDI's growth, and economic growth acceleration. Moreover, regarding official flows, the authors present a stabilizing function regarding the volatility of private capital flows, commodities prices, and output growth.

Analyzing the dynamics of foreign capital flows, Albuquerque et al. [2003] investigate mostly the FDI integrated into capital markets. This author develops an equilibrium model of world FDI and estimates an empirical model of panel data. According to this author, global factors are important in the dynamics of FDI, to both developed and developing countries. Besides, Albuquerque et al. [2003] af- firm that world integration of capital markets, productivity growth, trade openness, financial depth, low taxes, and macroeconomic stability affect the FDI in emerging economies.

De Vita and Kyaw [2008] find that foreign negative shocks have a more pronounced impact on the capital flows to the developing countries studied. Besides, a positive productivity shock affects positively the foreign direct investment (FDI).

Obstfeld [2012] emphasizes the relevance of net financial flows in the current account balance, using the descriptive analysis to accomplish that task. In that way, this author postulates that an imbalance in the current account can be financed in several ways, however, this can be secured by those partners whose current accounts are even. Besides, Obstfeld [2012] also stresses the importance of consolidated financial institutions to ensure that adequate pieces of information, aiming at helping decision making in cooperative international policies.

Forbes and Warnock [2012] use the gross capital inflows and outflows. They argue that after the 2008 crisis the net capital flows did not alter it too much, however, the gross capital flows change, decreasing between developed and developing countries, and rising among developed countries. They find that push factors are more important in determining the flows amongst countries than pull factors.

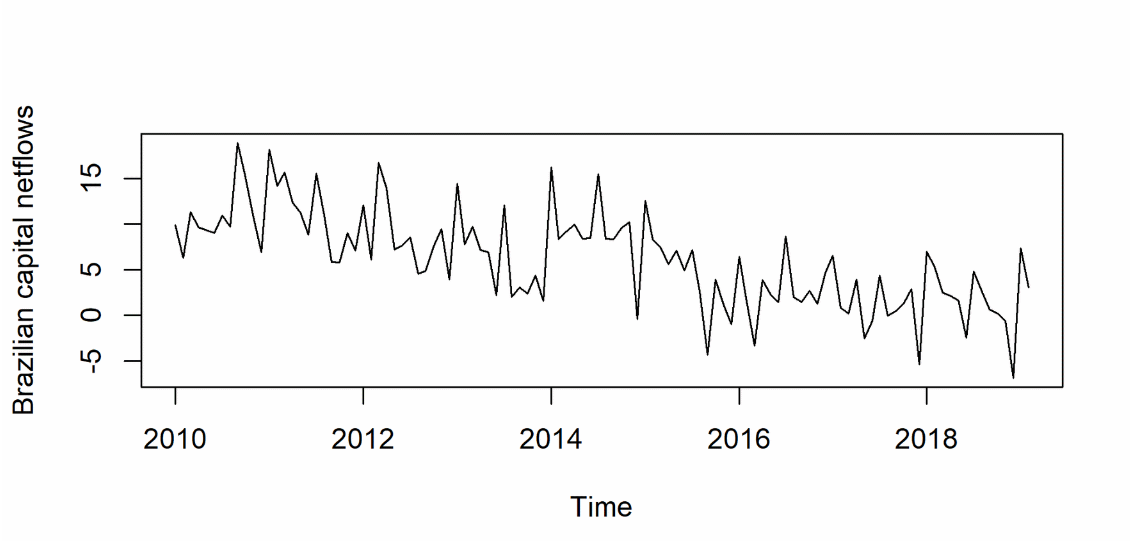
By analyzing the determinants of cross-border banking flows and the main channels of banking crises, Herrmann and Mihaljek [2010] use both dynamic and static panel methods to study stylized results of the literature. Nevertheless, they found new results by introducing the gravitational factor in their analysis. Their main results were: (i) global risk. (ii) crises of developing countries, and (iii) bigger financial integration and economic stability, affect the volume of cross-border loans.

3. DATA ANALYSIS

In order to study the long-run relationship between Brazilian net capital flows and the difference between Brazilian and American real interest rates, we now explain the origins of both series. Both series come from Institute of International Finance [2019] - net capital flows -, while both real interest rates come from the FRED St. Louis [2019b] and FRED St. Louis [2019c]. Both nominal interest rates series were deflated using their countries' respective consumer price indexes (CPI), from FRED St. Louis [2019a] and IBGE [2019]. Both nominal interest rates are those relating to the effective remuneration of public papers. Our studied time spans January 2010 to February 2019, every month. We also show a new difference of interest rates, weighted by a quotient of exchange rates in time $t-1$ and t, as $\frac{e_{t-1}}{e_t}$. In that way, $\frac{e_{t-1}}{e_t}>1$ implies, that according to the way Brazilian exchange rates are measured, that there was an appreciation of the Brazilian real, which makes investments in this currency more attractive. On the other hand, when $\frac{e_{t-1}}{e_t}<1$, we have the opposite, i.e., a depreciation of the Brazilian real, which implies that investments in Brazilian real are now less attractive. When we multiply this quotient by our original difference of interest rates, we aim at capturing possible dynamic effects of variations of the exchange rates on the capital netflows. This is appropriate given that foreign investors consider the exchange rates movements when deciding whether to invest in or disinvest from a country. We call this new difference of real interest rate times an exchange rates quotient as FX weighted difference of Brazilian and American real interest rates.

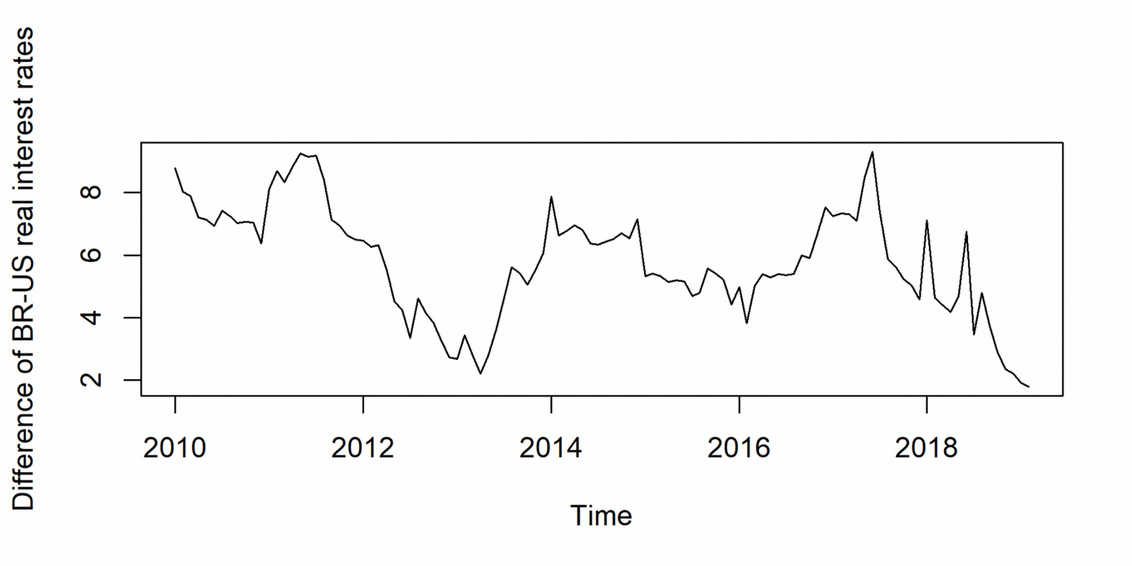
Initially, we show the graphical behavior of the three aforementioned series in Figure 1, 2, and 3.

FIGURE 1: Brazilian net capital flows



Note: Authors' own elaboration.

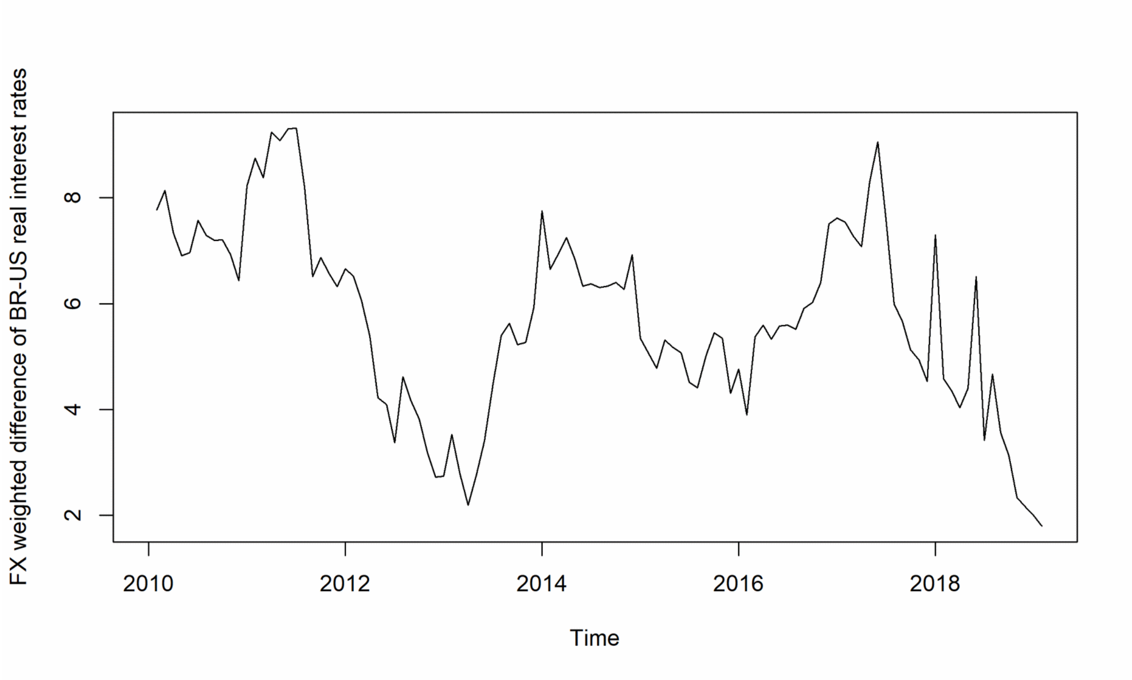
FIGURE 2: Difference between the Brazilian and American real interest rates



Note: Authors' own elaboration.

FIGURE 3: FX weighted difference between the Brazilian and American real interest

rates



Note: Authors' own elaboration.

The previous three graphs explicit that both series exhibit cyclical regularities (or seasonal). In that way, it is appropriate that both series share those cyclical regularities to some extent, that is, it is interesting that they behave similarly. It is noteworthy remembering that a cointegration process occurs when the series share cyclicalities in the low frequency[1].

4. METHODOLOGY[2]

Engle and Granger [1987] write that when a couple of series that are initially integrated of order 1 and then one series is projected over another and their residuals are stationary, we can say that those series are cointegrated. In the time domain, this means that even though in the short-run a shock in one series will change the behavior (mean and variance) of that series, in the long-run, both series will show a common trend (either deterministic or stochastic). Then, when a cointegrated series is projected on another, without any concern for their unitary roots, we will have a spurious regression as a result. To overcome this spuriousness, Engle and Granger [1987] suggest using an error-correction model. In that way, we use the residuals of the regression of the original non-stationary series as an explicative variable of a regression of the differentiated series, therefore purging our regression from both the unitary roots and the stochastic trend both series exhibit.

In the spectral domain, the concept of cointegration is widened. First, we require that both series are of the same order of integration, nevertheless that order must not be 1. In the frequency domain, it is possible that a series to be of a fractionary order, i.e., they may show a fractional unit root. In practical terms, this has the following implication. If a series is I(d), such as $0.5 \leq d < 1$, this series is stationary, however, its behavior might be volatile in the long-run, its observations return

[1]In the Appendices (1) and (2), we show the Autocorrelation Function (ACF) and the Partial Autocorrelation Function (PACF) as an initial investigation of the fractionary behavior of both the Brazilian capital netflows and the difference between Brazilian and American real interest rates.

[2] This topic is mostly based on the work of Beran et al. [2013].

to its average. This is considered a mean-reverting behavior. On another hand, if a series is I(d), such as $0 \leq d < 0.5$, this series is stationary, with well-behaved observations, i. e., its observations do not deviate severely from its mean.

Spectral analysis build upon the cointegration since it allows more options for the relationship of the order of both series. Instead of requiring that both series are I(1), we require that they are integrated of order I(d), with $d \leq 1$. In more precise terms, a cointegration process of two fractionary series demands that these series share the same order of fractionary integration statistically. Additionally, the residuals of the projection of a series on another must be of a lower order, statistically speaking, than the biggest order of integration in the original two series. In mathematical terms, we suppose that X and Y are fractionary series, with an order of integration of d. Then, we regress X on Y and we say that X and Y are cointegrated if their residuals are integrated of order d1, with $d1 < d$. To calculate the fractionary order of our series, we use the Geweke and Porter-Hudak [1983] estimator (henceforth GPH), known to use a sample of the observations of the series to calculate its order of integration, usually given by n^{band}, in which n is the total number of observations and $band < 1$ is the size of the subsample of the series used to calculate the fractionary order of integration. We use here two values for the band, which are 0.7 and 0.8 (value suggested by Beran et al. [2013] as the most important in GPH estimation).

In order to test whether two series share the same order of integration, we use a simple t-test of equality between the two orders of integration between our series. In our case, the test statistic will be given by $t = \frac{d_{difference} - d_{flows}}{sd.as_{difference=flows}}$. If there is equality between the two series and we can analyze them in light of fractionary cointegration, then we also need to test whether the residuals of the projection of a series on another have a lower order of integration than the biggest order of the original series.

After verifying that our series satisfy our conditions for fractionary cointegration, we can then estimate our aimed relationship between the Brazilian capital netflows and the difference between the Brazilian and the American real interest rates, correcting for a possible spurious relationship between our series. We then make analysis very similar to a cointegration of order 1 process between our series. We first differentiate our series fractionally by their order of integration to make them stationary. Then, we regress the differentiated capital netflows series on the differentiated gap of real interest rates. Additionally, to capture the long-run relationship between those two series, we take the residuals of their regression in levels and insert them on the differentiated regression. This new regression corrects the spurious relationships between two non-stationary series that share a stochastic trend while considering the long-run relationship between the original series.

Alongside the aforementioned methodology, there is another method of corroborating the existence of cointegration between two series of fractionary order of integration. Spectrally, one time series can be described by a periodogram, which is a synthetic way to transform a series from the time domain to the frequency do- main, through the Fourier transform. The periodogram alone has some interesting properties[3], such as its peaks describe the frequency that creates more variability to the series. Hence, if a series has a periodogram that peaked at lower frequencies, this means that the variability of this series comes from long-run variations. Similarly, if a series has a periodogram that peaked at higher frequencies, this means the variability of the series comes from short-run variations. Besides the periodogram of a single series, it is possible to analyze the co-movement of two series in the frequency domain, through the coherence, which is built with cross-specter, a “correlation” of two series in the frequency domain, and the simple product of the periodograms of the two series. The coherence is calculated by the following formula in Equation 1:

[3] Check Beran et al. [2013] for more information.

$$0<k_{xy}^{2}(w)=\frac{\left(\left|f_{xy}(w)\right|\right)^{2}}{f_{x}(w)f_{y}(w)}<1 \qquad (1)$$

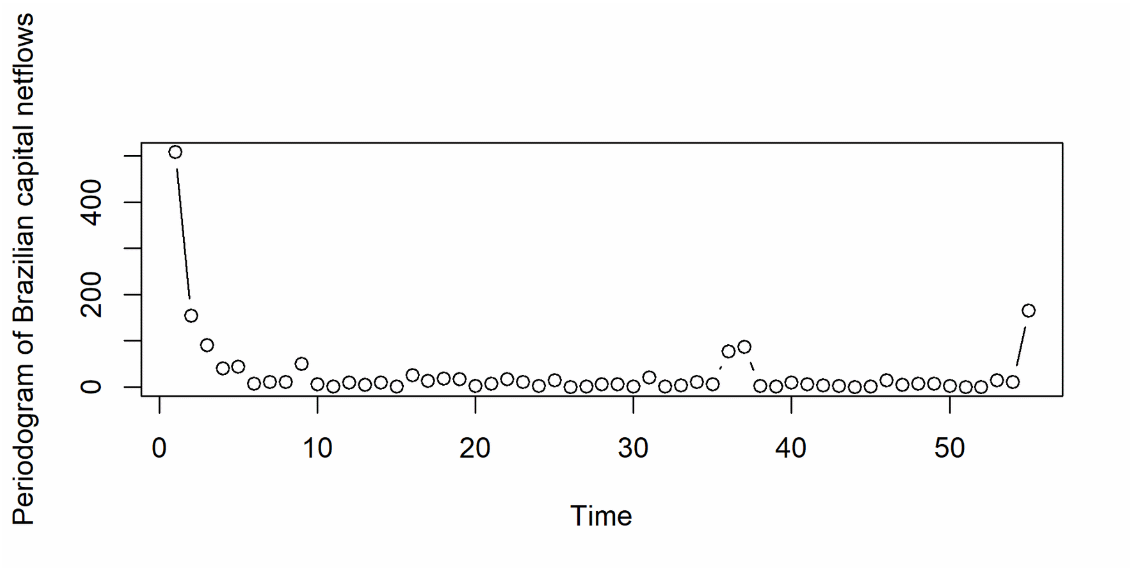
In which $f_{xy}(w)$ is the cross-spectrum and $f_x(w)$ and $f_y(w)$are both spectrum (or their periodograms). The coherence is calculated for each frequency in the interval , and is in the interval $[0,1]$. The coherence at lower frequencies shows how much aligned the movements of a series are in the long-run (lower frequency, longer cycle). So we expect in our analysis that besides the regression results, the coherence at lower frequencies displays significant values. This emphasizes that the long-run relationship is important enough to influence how the series interact with each other at lower frequencies.

5. RESULTS

5.1 Frequency Domain Analysis

Next, we present the periodogram of the Brazilian capital netflows in Figure 4.

FIGURE 4: Periodogram of the Brazilian capital netflows



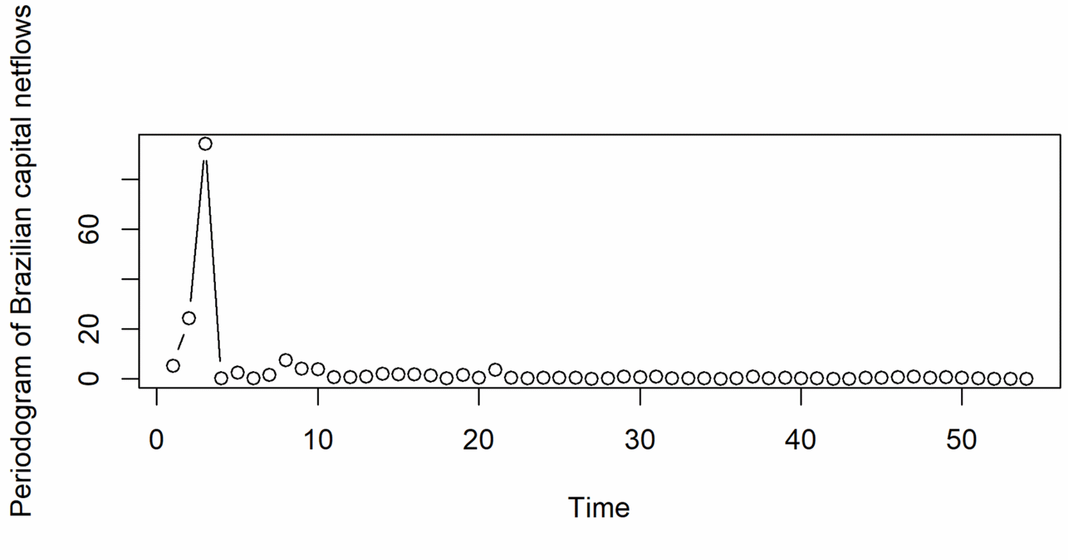
Note: Authors' own elaboration.

We see in Figure 4, that the significative frequencies, i. e., the frequencies which contribute statistically to the variance of the series are, at 5%, 1, 2, 3, and 55. They correspond to the cycles of 55, 27.5, 18.3, and 1 month(s), respectively. This periodogram shows that there are cycles in the aforementioned series. Nevertheless, we must observe that at the cycle of the lowest frequency, that is, the longest cycle, which corresponds to the cycle of 55 months, we only have one repetition of this cycle. Given that we have N=110, in which N is the number of periods in our sample, we may misjudge in analyzing if this significance is a sign of cycle long or it emphasizes the long memory of our data[4].

[4]This is due to the fact that long memories processes' variability occurs because of the long-run behavior of the series. Therefore, a long memory process will have naturally peaks at lower frequency.

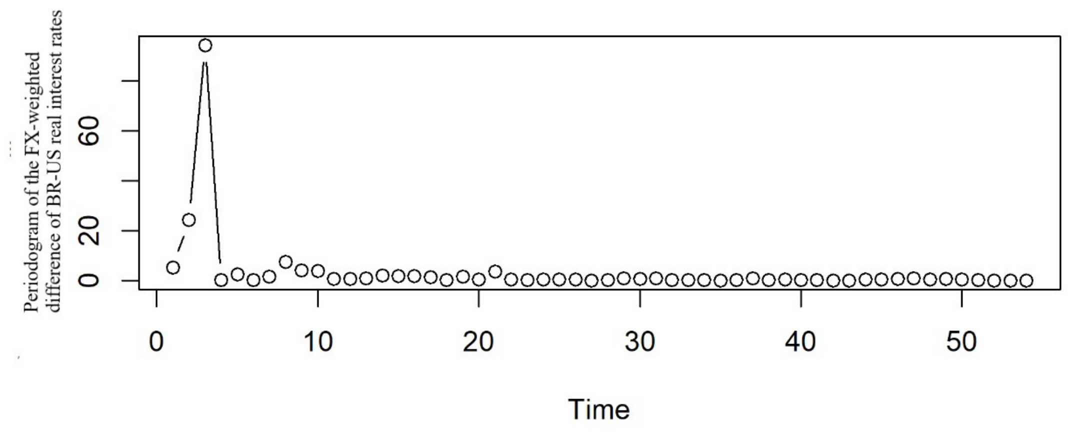
In the following Figures 5 and 6, we display both periodograms of the series of the difference between the Brazilian and American real interest rates, first without weight and then weighted by the FX quotient.

FIGURE 5: Periodogram of the difference of BR-US real interest rates



Note: Authors' own elaboration.

FIGURE 6: Periodogram of the FX weighted difference of BR-US real interest rates



Note: Authors' own elaboration.

In both case, the significant frequencies are 2 and 3, which correspond to the cycles of 27.5 and 18.3 months, respectively.

Before continuing the analysis, we choose to deseasonalize the Brazilian capital netflows series. As we showed in the periodogram of this series, the frequency 55, highest and corresponding to the cycles of 1 month, was significative, hence we remove it from the series. The other frequencies are of longer cycles and as cointegration is a long-run process, we leave those lower frequencies intact in the series.

5.2 Frequency Domain Analysis

In Table 1, we present the GPH estimator for the fractionary order of our three series, using the bands of 0.7 and 0.8. We also present the number of observations used in each regression of the GPH estimator.

TABLE 1: Fractionary order of the three series of the Brazilian capital netflows, the normal and FX weighted difference between the Brazilian and American real interest rates

Band	Brazilian capital netflows	Difference between BR-US real interest rates	FX weighted difference between BR-US real interest rates	Number of observations
0.7	0.6830942	0.5709853	0.5709853	27
	(0.1575502)	(0.1575502)	(0.1576357)	
	[0.1284298]	[0.1884278]	[0.1494902]	
0.8	0.54253	0.6720247	0.66899151	43
	(0.1226056)	(0.1226056)	(0.1227746)	
	[0.1125998]	[0.1395457]	[0.123876]	

Source: Authors' own elaboration. The asymptotic standard deviation is reported inside the parentheses, while the regression standard deviation is reported inside the brackets.

Now, in Table 2, we test nullity and unity of the fractionary order of integration of our three series. We consider the asymptotic standard deviations reported in Table 1 and also use the band interval equal to 0.8, as suggested by Beran et al. [2013].

TABLE 2: Nullity and Unity test of the fractionary order of integration of the Brazilian capital netflows and normal and FX weighted Difference between BR-US real interest rates

Test	Brazilian capital netflows	Difference between BR-US real interest rates	FX weighted difference between BR-US real interest rates
Nullity ($d = 0$)	4.425001	5.48119	5.619361
	(4.818214)	(4.815804)	(5.569402)
Unity ($d = 1$)	-3.731232	-2.675043	-2.525643
	(-4.062795)	(-2.350308)	(-2.503189)

Source: Authors' own elaboration. The test statistic with the asymptotic standard deviation is reported in the line, while the test statistic with the regression standard deviation is reported insides the parentheses.

Considering both tests as unilateral and the 5% significance cut, we have that our table statistics is 1.66. Hence, we cannot accept the null hypothesis of nullity and unity for both series, using the asymptotic standard deviations. We then conclude that the order of our three series is fractionary integrated.

Now we test whether the fractionary order of the both series of difference of real interest rates is equal statistically to the order of our Brazilian capital netflows. This is implemented by a simple t-test. We again use the band of 0.8, as suggested by Beran et al. [2013].

$$t = \frac{d_{difference} - d_{flows}}{sd.as_{difference=flows}} = \frac{0.54253 - 0.6720247}{0.1226056} = -1.056188 \quad (2)$$

$$t = \frac{d_{difference} - d_{flows}}{sd.as_{difference=flows}} = \frac{0.54253 - 0.6899151}{0.1227746} = -1.200451 \quad (3)$$

Hence, we cannot reject the null hypothesis that the fractionary orders of both series of Brazilian capital netflows and the gap of real interest rates are equal, weighted by FX or not. In that way, the first criterion for the existence of cointegration of the two series of the difference of interest rates and the series of Brazilian capital flows is met. Furthermore, we only need to guarantee now that the residuals of the projection of the Brazilian capital netflows on the difference of real interest rates, weighted by FX or not, have a lower order of integration than the original series. First, we display the results of this projection in Table 3.

TABLE 3: Regression of the Brazilian capital flows on the the difference of Brazilian and American real interest rates, normal and weighted by FX quotient

Variable	Coefficient	Coefficient of weighted difference by FX quotient
Constant	3.7675*	-3.7790**
	(1.9867)	(1.9795)
Difference on BR-US real interest rates	0.9346***	0.9519***
	(0.2464)	(0.2475)

Source: Authors' own elaboration. *** p < 0.01, ** p < 0.05, * p < 0.1. The standard deviations are reported insides the parentheses.

In the Appendices (1) and (2), we present the graph of the residuals of the last regression. We then present in Table 4 the order of integration of the residuals of the last two regressions and then compare this order with the ones of the two-original series.

TABLE 4: Order of integration of the residuals of Brazilian capital netflows regressed on the difference of the BR-US real interest rates weighted by FX and otherwise

Band	Residuals based on the difference between BR-US real interest rates	Residuals based on the FX weighted difference between BR-US real interest rates	Number of observations
0.7	0.518028	0.58218	27
	(0.1575502)	(0.1576357)	
	[0.2052273]	[0.2360694]	
	0.4471052	0.4591514	43
0.8	(0.1226056)	(0.1227746)	
	[0.1592755]	[0.1722107]	

Source: Authors' own elaboration. The asymptotic standard deviation is reported inside the parentheses, while the regression standard deviation is reported inside the brackets.

Then, we test whether the order of integration of the aforementioned residuals is lower than the order of integration of the two-original series of its regression This test is implemented using a t-test, which produces the following statistics:

$$t = \frac{d_{difference} - d_{flows}}{sd.as_{difference=flows}} = \frac{0.4471052 - 0.6720247}{0.1226056} = -1.834495 \quad (4)$$

$$t = \frac{d_{difference} - d_{flows}}{sd.as_{difference=flows}} = \frac{0.4591514 - 0.6899151}{0.1227746} = -1.879571 \quad (5)$$

We then conclude that we cannot accept the null hypothesis that the residuals' order of integration is equal to the biggest order of integration of the two-original series of its regression. Hence, there is sufficient evidence to suggest that the Brazilian capital netflows and the difference between the Brazilian and American real interest rates, FX weighted or not, are indeed cointegrated. In other words, they share co- movements in the long-run.

In Table 5, we present the results of the error-correction model. Again, we differentiated the original series by their respective orders of integration and we use the residuals of the regression of both variables in level as an independent variable. This procedure is adopted as a way to correct the spurious results of our first regression.

TABLE 5: Error-corrected regression of the deseasonalized Brazilian capital netflows on the difference of Brazilian and American real interest rates

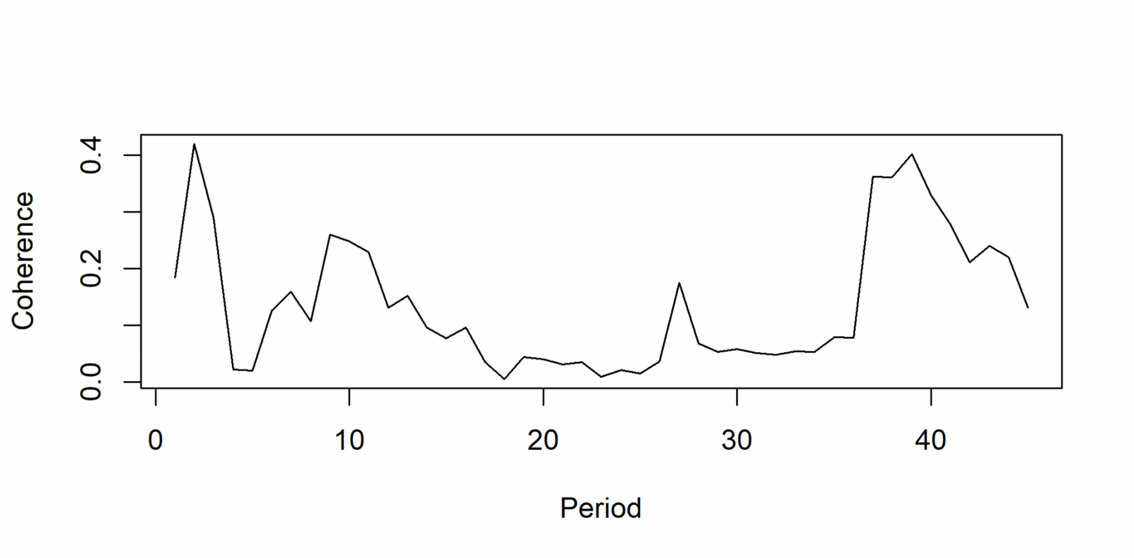
Variable	Coefficient	Coefficient of weighted difference by FX quotient
Constant	-0.11857	-0.057
	(0.37222)	(0.40378)
Difference on BR-US real interest rates	0.72780*	0.88891*
	(0.42909)	(0.44277)
Residuals	0.42240***	0.36777***
	(0.08882)	(0.09629)

Source: Authors' own elaboration. *** p < 0.01, ** p < 0.05, * p < 0.1. The standard deviations are reported insides the parentheses.

The last regressions are interpreted in the following way: the increase of 1 per- centage point in the difference of Brazilian and American real interest rates implies growth of approximately $727.80 million in the Brazilian capital flows, while this value is around $888.91 in the same variation in the difference of Brazilian and American real interest rates, weighted by the FX quotient, as explained in the methodological section.

Following the past analysis, we present in Figure 7, the coherence between the series of Brazilian capital netflows and the difference of Brazilian and American real interest rates.

FIGURE 7: Coherence of Brazilian capital netflows and the difference of Brazilian and American real interest rates



Note: Authors' own elaboration.

Now, we present those same results in Table 6, displaying those frequencies where the coherence is significant at 5%.

TABLE 6: Significant coherence between Brazilian capital netflows and the difference of Brazilian and American real interest rates

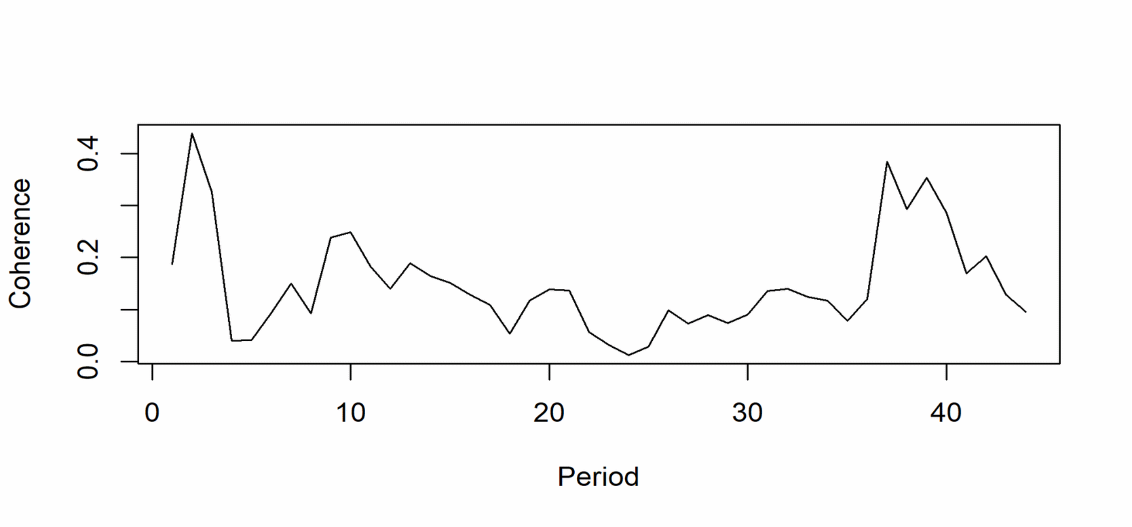
Frequency	Coherence	Period	P-value
1	0.184409213	10	0.0256
2	0.420081875	8.461538	0.0002
3	0.289924139	7.333333	0.003
9	0.259568646	4.074074	0.0056
10	0.248208582	3.793103	0.0071
11	0.22881728	3.548387	0.0105
13	0.151676197	3.142857	0.0492
27	0.174724982	1.746032	0.0311
37	0.362161999	1.325301	0.0006
38	0.36146192	1.294118	0.0007
39	0.402459504	1.264368	0.0003
40	0.328755146	1.235955	0.0013
41	0.277791752	1.208791	0.0038
42	0.21060544	1.182796	0.0151
43	0.239610593	1.157895	0.0084
44	0.220079397	1.134021	0.0125

Source: Authors' own elaboration.

Although the squared coherence is not similar statistically to 1 at the lower frequencies, it is significantly different from 0, which indicates that both series share co-movements in the long- run. It is noteworthy that the coherence calculation uses a band for its computation and we use 10 observations as its band. This is the reason for the coherence calculation ends at 45, not at 55.

Now we present the last analysis of coherence in the Figure 8 and Table 7, regarding the Brazilian capital netflows and the FX weighted difference of Brazilian and American real interest rates.

FIGURE 8: Coherence of Brazilian capital netflows and the FX weighted difference of Brazilian and American real interest rates



Note: Authors' own elaboration.

Now we present in Table 7 the frequencies of the coherence which are significant at 5%.

TABLE 7: Significant coherence between Brazilian capital netflows and the FX weighted difference of Brazilian and American real interest rates

Frequency	Coherence	Period	P-value
1	0.18749972	9.909091	0.0241
2	0.43853403	8.384615	0.0001
3	0.32619501	7.266667	0.0014
9	0.23891540	4.037037	0.0085
10	0.24856349	3.758621	0.0070
11	0.18270004	3.516129	0.0265
13	0.18941698	3.114286	0.0232
14	0.16484159	2.945946	0.0379
37	0.38408103	1.313253	0.0004
38	0.29297256	1.282353	0.0028
39	0.35375079	1.252874	0.0008
40	0.28574085	1.224719	0.0033
41	0.16948425	1.197802	0.0345
42	0.20296084	1.172043	0.0177

Source: Authors' own elaboration.

Again, there are significant coherence at lower frequencies emphasizing that the Brazilian capital netflows and the FX weighted difference of Brazilian and Ameri- can real interest rates share co-movements in the long-run.

6. FINAL REMARKS

In this present work, we analyzed the cointegration of the difference between the Brazilian and American real interest rates and the Brazilian capital netflows, normal and weighted by an FX quotient. We found that there is enough evidence to support our claim that there is cointegration between the first series and each of the second series. Nevertheless, our way of defining cointegration processes were widened by using the instrumental of spectral analysis, which allows to consider more possibilities in a cointegration vector.

In that way, we found a positive and significant effect of a higher difference between Brazilian and American real interest rates, weighted by FX or not, on the Brazilian capital netflows. This is possibly caused by the portfolio effect in the domestic market in the short-run and an interaction between current account and monetary policy in the long-run.

Future works may be interested in working on expanding our present analysis to a group of other countries and verifying whether our conclusion hold to a bigger sample or not. Furthermore, these works may also be interested in working with the disaggregated components of the capital account and analyzing their possible cointegrating behavior with a series of difference of real interest rates between some country and American rates.

REFERENCES

Albuquerque, R., Loayza, N., and Serve´n, L. (2003). *World market integration through the lens of foreign direct investors*. The World Bank.

Beran, J., Feng, Y., Ghosh, S., and Kulik, R. (2013). *Long-Memory Processes.*

Springer.

Byrne, J. P. and Fiess, N. (2011). International capital flows to emerging and devel- oping countries: national and global determinants.

Calvo, G. A., Leiderman, L., and Reinhart, C. M. (1993). Capital inflows and real exchange rate appreciation in latin america: the role of external factors. *Staff Papers*, 40(1):108–151.

Cardoso, E. and Goldfajn, I. (1998). Capital flows to brazil: the endogeneity of capital controls. *Staff Papers*, 45(1):161–202.

Dasgupta, D. and Ratha, D. (2000). What factors appear to drive private capital flows to developing countries? and how does official lending respond?

De Vita, G. and Kyaw, K. S. (2008). Determinants of capital flows to developing countries: a structural var analysis. *Journal of Economic Studies*, 35(4):304–322.

Engle, R. F. and Granger, C. W. (1987). Co-integration and error correction: rep- resentation, estimation, and testing. *Econometrica: journal of the Econometric Society*, pages 251–276.

Fernandez-Arias, E. (1996). The new wave of private capital inflows: push or pull? *Journal of development economics*, 48(2):389–418.

Forbes, K. J. and Warnock, F. E. (2012). Capital flow waves: Surges, stops, flight, and retrenchment. *Journal of International Economics*, 88(2):235–251.

Fratzscher, M. (2012). Capital flows, push versus pull factors and the global finan- cial crisis. *Journal of International Economics*, 88(2):341–356.

FRED St. Louis (2019a). Consumer Price Index for All Urban Consumers: All Items. https://fred.stlouisfed.org/series/CPIAUCSL#0. On- line; accessed 02 May 2019.

FRED St. Louis (2019b). Effective federal fund rates. https://fred.stlouisfed.org/series/FEDFUNDS. Online; accessed 02 May 2019.

FRED St. Louis (2019c). Interest Rates, Government Securities, Treasury Bills for Brazil. https://fred.stlouisfed.org/series/INTGSTBRM193N. Online; accessed 02 May 2019.

Geweke, J. and Porter-Hudak, S. (1983). The estimation and application of long memory time series models. *Journal of time series analysis*, 4(4):221–238.

Grubel, H. G. (1968). Internationally diversified portfolios: welfare gains and cap- ital flows. *The American Economic Review*, 58(5):1299–1314.

Herrmann, S. and Mihaljek, D. (2010). The determinants of cross-border bank flows to emerging markets: new empirical evidence on the spread of financial crises.

IBGE (2019). Índice Nacional de Preços ao Consumidor Amplo - IPCA. ftp://ftp.ibge.gov.br/Precos_Indices_de_Precos_ao_Consumidor/IPCA/Serie_Historica/ipca_SerieHist.zip. Online; accessed 02 May 2019.

Institute of International Finance (2019). Monthly net capital flows database. https://www.iif.com/content/ monthly-net-capital-flows-database. Online; accessed 02 May 2019.

Koepke, R. (2019). What drives capital flows to emerging markets? a survey of the empirical literature. *Journal of Economic Surveys*, 33(2):516–540.

Montiel, P. and Reinhart, C. M. (1999). Do capital controls and macroeconomic policies influence the volume and composition of capital flows? evidence from the 1990s. *Journal of international money and finance*, 18(4):619–635.

Obstfeld, M. (2012). Financial flows, financial crises, and global imbalances. *Jour- nal of International Money and Finance*, 31(3):469–480.

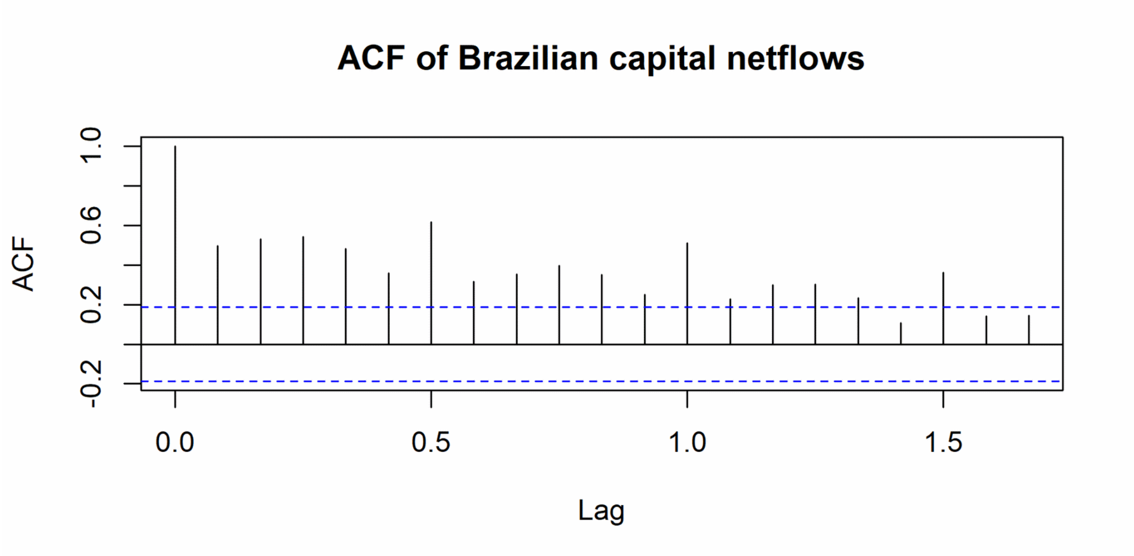
Taylor, M. P. and Sarno, L. (1997). Capital flows to developing countries: long-and short-term determinants. *The World Bank Economic Review*, 11(3):451–470.

APPENDIX

A

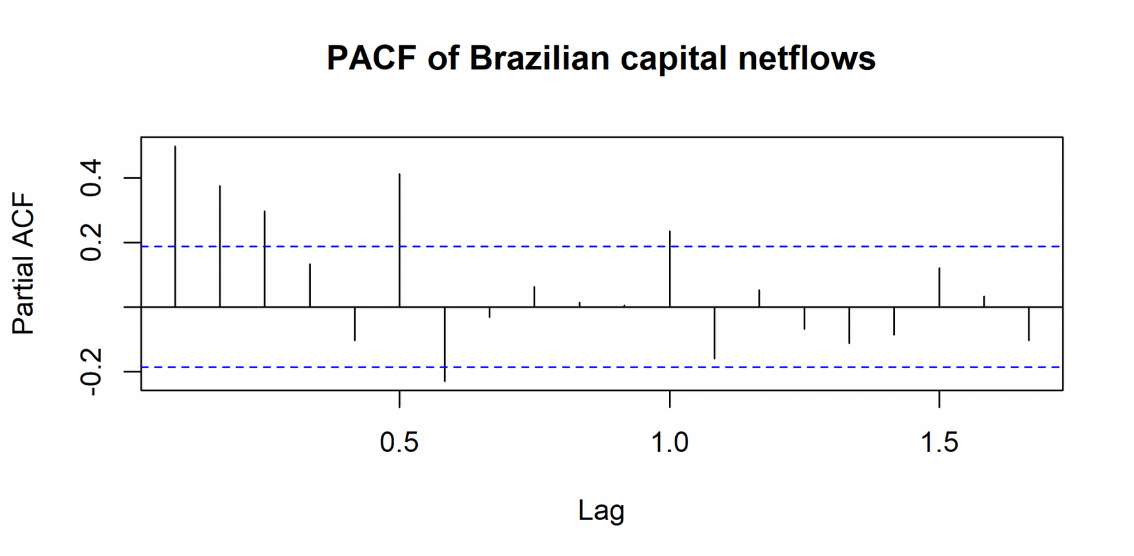
ACF and PACF of the Brazilian capital netflows

Figure 9:



Note: Authors' own elaboration.

Figure 10:



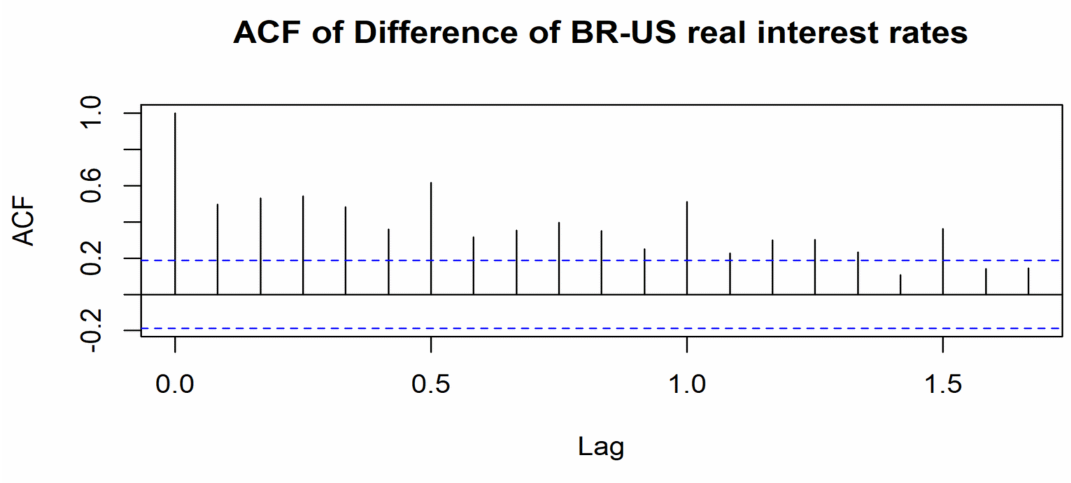
Note: Authors' own elaboration.

By the previous graphs, we can see that the series of Brazilian capital netflows exhibits a behavior relatively converging of its ACF and PACF, which is an indicator of its stationariety. Nevertheless, the series' ACF and PACF do not converge to 0, suggesting the presence of long memory in the data generating process (DGP) - the behavior of a fractionary process.

B

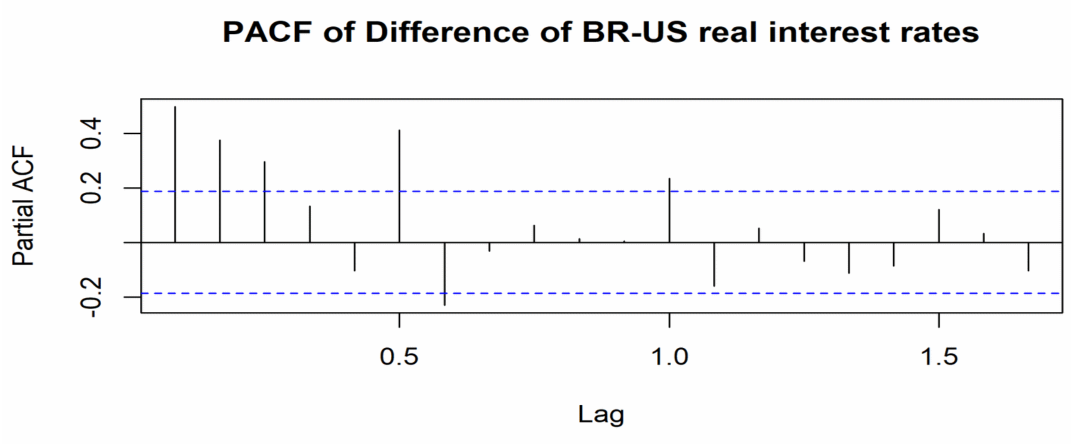
ACF and PACF of the difference of the Brazilian and the American real interest rates

Figure 11:



Note: Authors' own elaboration.

Figure 12:



Note: Authors' own elaboration.

In that way, we see similar behavior to the series of Brazilian capital netflows, suggesting again a long-memory process, that is, a fractionary DGP.