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INTEGRATION AND CONTAGION OF BRIC FINANCIAL MARKETS

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Abstract

We add to the debate promoted by Misra and Mahakud (2009) and Chittedi (2010) aiming to measure the levels of financial integration and contagion of BRIC. We follow Vahid and Engle (1993) and Johansen et al (2000) in order to extract individual and common trends and cycles of BRIC major stock market indices. Our evidence in the short-run suggests a contagion effect with Brazilian and Chinese financial markets playing a leading role, which can be useful to worldwide investors that should consider reactions in these markets during crisis as a predictor of other BRIC reactions through the contagion channel. In the long-run we are able to identify three common scenarios: one of them reflecting a possible converging trajectory for BRIC financial markets, and the other ones following negative risk drivers still incorporating the effects of the recent crisis, without recovery of these markets. This finding suggests that BRIC financial markets are linked, even in an environment without the desirable level of harmonization of respective stock markets with the international rules and regulations.

Key words:

BRIC Stock Market Indices; Common Trends; Common Cycles.

INTRODUCTION

Since the pioneering customs unions in the nineteenth century, the society has observed an ongoing process characterized by the formation of various types of blocs based on the mutual benefit and efficiency gain in terms of commercial or monetary transactions for the economies involved.[1] However, more recently we can observe a different phenomenon. There seems to be a favorable scenario for the imagination of financial market, which creates at random acronyms that sound good to the ear, attracting the attention of academics, practitioners and policy makers in the direction of some selected economies. In this context, Goldman Sachs first used

[1]One can see Warwick (1994) on the impacts of North American Free Trade Agreement (NAFTA), Bergsten (1997) on Asia-Pacific Economic Cooperation (APEC), Flores (1997) on Southern Common Market (MERCOSUR), while Winters (1993, 1994) and Bayoumi and Eichengreen (1997) are good references on the impacts of commercial arrangements in Europe.

in 2001 the term BRIC, referring to a subset of emerging economies – Brazil, Russia, India and China – that should play a leading role in the global economy. From this creation, many other suggestions of grouping of countries emerged.[2]

As extensive as the imagination of financial market is the related literature. However, why should we care about foundationless acronyms creation? Probably, because the economies composing these "ex ante" fake blocs are taking this opportunity as an incentive to form real economic blocs, sending an image that they are homogeneous or complementary and also share common features. Here, we enter this vast debate by analyzing how appropriate in financial terms is the use of one of these acronyms, BRIC, supported by the evidence of how financially integrated is this bloc and how strong is the financial contagion across Brazil, Russia, India and China.

More specifically, we aim to analyze if BRIC main stock indices share an equilibrium relationship so that they cannot move independently in the long- and short-run, during the period from January 1998 to November 2010. In this context, we are conceptually aligned with Bai (2008, 2009), Misra & Mahakud (2009), Verbus & Sportel (2012), and Çakir & Kabundi (2013). Methodologically, we follow Vahid & Engle (1993), and Johansen et al., (2000) in order to address this issue in the sense of D'Ecclesia & Costantini (2006), Matos et al., (2014a) and Matos et al., (2014b). Given our purpose, this paper parallels the work of Chittedi (2010).

It is not easy to draw parallels between our evidences and previous findings because most of studies about stock market integration use to analyze it within developed markets instead of emerging ones. Though, the literature specifically about this issue involving BRIC seems to be scarce. Anyway, observing some previous related studies, all of them evidence long-run relationship, but they are not consensual about the influence in the short-run.

Our results of the individual decomposition suggest that short-run reactions during Russian and Brazilian crisis are comparable to the deviations occurred during the global crisis. We also find that Brazilian and Chinese financial markets exert relatively higher influence in the short run. This is useful to investors as a signal regarding their power to forecast other BRIC reactions through the cycle transmission channel. In the long-run, the identification of three common scenarios has implications for policy makers, providing them fundamentals to adopt more

[2]In 2008, Financial Times proposed the pejorative term PIIGS for some European countries with high levels of debt and public deficit. In 2010, Passport Capital attracted the eyes of the world for the CASSH, an acronym that stands for five developed countries: Canada, Australia, Singapore, Switzerland and Honk Kong. In 2011, a new set of up-and-coming emerging markets was gaining attention as hot markets with fast-growing populations, relatively stable political environments and the potential to produce outsized returns in the future: the CIVETS, as a reference for Colombia, Indonesia, Vietnam, Egypt, Turkey and South Africa. In an online post highlighting the top 10 risks of 2013, Eurasia Group warns of the perils of Japan, Israel and Britain, the JIB.

appropriate stock market regulations, as well as motivating a discussion about a globalization intra-bloc in terms of alliances of the respective stock market exchanges.

The relevance of our findings are due first to the size of this bloc, which occupies 26% of the world's land coverage, where 45% of the world's population live in. Moreover, these economies used to share 14.2% of total trade in the world market in 2008, according to Organisation for Economic Co-operation and Development (OECD) and BRIC Gross Domestic Product (GDP) in 2010 US$ on Purchasing Power Parity basis was about 24.9% of world GDP, according to International Monetary Fund (IMF).

Second, BRIC is very heterogeneous. This bloc is formed by a market economy with a high level of inequality, poverty, democracy and urbanization, an ex-socialist superpower with high per capita income and human capital levels, a predominantly rural country with strong cultural and religious divergences and a communist dictatorship with a high degree of trade openness and high level of international reserves.

Observing specifically the respective stock markets, the divergences remain. In 2010, the Chinese market capitalization of US$ 5.7 trillion was more than four times the Russian amount. The difference regarding the number of domestic companies listed is notably: India with more than 5,000, while Brazil has less than 500.

Third, we know that a higher level of contagion in partner economies can promote a process of strengthening the domestic markets involved, which is essential for the domestic corporate environment and contributes to capital accumulation and technological innovation: key elements for economic growth. The literature points the information asymmetry as a relevant element in the transition mechanism of contagion between emerging markets.

However, BRIC are not located in the same geographic region, they do not share many similarities in terms of market structure nor history, and the direct linkages through trade and finance are not so strong yet: the amount of US$ 320 billion in 2011 of intra-BRICS trade was a small fraction of their trade, less than 5%, according to data from the International Trade Center. In financial terms, when we observe the foreign direct investment (FDI) amount, inflows to BRIC come mainly from outside the bloc, which is also true for outflows of FDI from BRIC, according to Mathur & Dasgupta (2013).[3]

To summarize, according to the following quote from Goldman Sachs (2001)'s report: "Clearly, the four countries under consideration are very different

[3] See Holtbrügge and Kreppel (2012) for a recent study about foreign direct investment issue in BRIC.

economically, socially and politically, […]". As can be seen in this complex scenario, it is not obvious to infer about common long-term trajectories associated with economic fundamentals or about how these markets will react to global or local shocks in the short-run.

This article is structured into five sections including this introduction. Section 2 gives an account of the empirical literature about financial integration and contagion, before explaining the methodology in the third section. We present the results in the fourth section and the final considerations are in the fifth.

LITERATURE REVIEW

Quinn (1997), Kose et al., (2006), and Henry (2007) are relevant sources of discussion about concepts and measures of integration. Among other approaches, we mention a well succeed researching route developed by Taylor & Tonks (1989), Kasa (1992), and Masih & Masih (2001) that follows Engle & Granger (1987), and Johansen (2000), based on the existence of cointegrating vectors formalizing a long-term relationship as useful to infer about integration of samples of economies.

This cointegration framework is useful to distinguish between the nature of long-run and of short-run linkages among financial markets and also captures the interaction between them. This methodology seems to be more appropriate also because it allows us to infer about long-run and short-run relationships under the same set of assumptions, very mild by the way if compared to other ones. [4]Thus, this technique has been widely used in macroeconomic studies to analyze the transmission of business cycles between countries, or even between sectors of the economy, as in Engle & Issler (1995). However, for financial purposes, there is not a vast application.

From the methodological perspective, if there are comovements, it is possible to synthesize complex systems into a simpler structure of common components. Therefore, following Granger & Weiss (1983), Engle & Granger (1987), Stock & Watson (1988), and Engle (1997), we are also able to analyze other common characteristics in the sense of Engle & Kozicki (1993). Among these characteristics, the presence of common cycles is useful to infer about contagion between financial markets, an issue explored conceptually in Claessens & Forbes (2004). According to them, the financial crises of the late 1990s prompted extensive empirical research on contagion, as in Chan-Lau et al., (2004), and Majid & Kassim (2009).

Here, we extract individual and common cycles, following Vahid & Engle (1993), and then, we employ Granger Causality with the aim of inferring about the influence

[4]Convergence exercises of financial indicators are also useful to study integration, although most techniques are not robust to structural breaks. Following this approach, Antzoulatos et al. (2011) and Matos et al. (2011) apply the Phillips and Sul (2007) method to financial and economic indices worldwide, while Furstenberg and Jeon (1989), Bianco et al. (1997) and Schmidt et al. (2001) limit the sample to developed countries.

of temporary deviations of the trajectory of each financial market on other markets.[5] We are able to analyze comovements in BRIC stock indices, which enables us to test for contagion controlling for the role of economic fundamentals – captured by trends –, a common source of omitted variables. Although the volatilities are higher during the periods of crisis, we do not have heteroskedastic cycles.

Finally, we can deal with endogeneity by employing VAR specification to model stock market returns, which also helps to account for serial autocorrelation in returns (Pick, 2007; Forbes & Rigobon, 2002).

In studies methodologically similar to our paper, such as Hecq et al., (2000), Morley & Pentecost (2000), Sharma & Wongbangpo (2002), and Westermann (2002), the results of long- and short-term comovements between financial indices are also used to analyze market efficiency, market equilibrium, price equalization, portfolio diversification or even to make inferences on which financial markets are more influential than others in specific groups of countries. In turn, D'Ecclesia & Costantini (2006) discuss aspects related to international diversification associated with a portfolio composed of the indices analyzed, finding evidence of a single common cycle and low explanatory power of diversification in the short run.

Regarding specific studies that limit the analysis to samples containing BRIC stock markets, Bai (2008) analyzes this bloc's financial integration based on a multivariate VAR and impulse-response function applied to daily series of returns on BRIC stock markets indices, besides Mexico and some developed economies, during a time span from 1994 to 2006. This study evidences a partial integration level, which increases by fixed exchange regimes and during the crisis period. A stronger result is reported in Bai (2009), who evidences that the BRIC financial markets, the foreign exchange and equity markets are fully integrated with the world market and among themselves, with Brazil exerting the highest level of integration, followed by Russia, India and China.

Chittedi (2010) employs a cointegration approach, but over a more recent period – daily data from 1998 to 2008. The main conclusions suggest that BRIC share a long run equilibrium, with a contagion transmission characterized only by the influence of Indian financial market on Brazilian and Russian ones.

In Verbus & Sportel (2012), the aim is to measure the effect of the contagion caused by the US debt crisis. The authors conclude that it is not the strength of the linkages that matters the most, but more the stability and prudence of country's banking sector, which it is observed in Brazil. In less integrated countries, as China, Russia and India, short-term measures seem to work better than the long term measures.

[5]Another test of common cycles is described in Carvalho et al. (2007).

Addint to this discussion, we aim to evidence if the null hypothesis of financial integration and contagion holds, based on empirical exercises that use broad national indices as proxy for BRIC stock markets. Among others, as the sample of stock indices or the period analyzed, one main difference of our procedure is that we apply a methodology robust to structural break to BRIC stock indices. More specifically, first, we test here if cumulative returns on the main BRIC stock indices cointegrate, i.e., if there are common stochastic trends implying a relationship of long-term equilibrium between them. The null hypothesis of financial integration depends on the real economic linkages between BRIC, which are clearly different.[6]

Objectively speaking, our second null hypothesis attempts to the presence of financial contagion in BRIC. Theoretically, financial markets in emerging market countries with strong economic linkages appear to be more vulnerable to contagion, mainly if there are financial crisis that can act as a common shock to these countries. The information asymmetry can also be relevant as transition mechanism of contagion between emerging markets.

METHODOLOGY

Stationarity and structural break

Series of returns on assets are usually stationary, but the same does not hold when we observe series of cumulative gains, which carry some of the statistical properties of the series of asset prices. Here, we use cumulative gain of a local investor in his own main stock market index, which may oscillate around a trend, deterministic or stochastic. This suggests us to perform stationarity tests as the first methodological stage.

Each test seems to be more appropriate due to the power of the test, the presence of serial autocorrelation or heteroskedasticity of residuals, and the size of sample. So, we perform four usual unit root tests:

i) The augmented version (ADF) of the test originally proposed in the Dickey & Fuller (1979, 1981);

ii) The semi-parametric framework suggested in Perron & Phillips (1988);

iii) The method developed by Elliot et al., (1996); and

iv) The technique proposed in Perron & Ng (1996).

We show these results in Table 3, Panel A. However, when we are dealing with series that can be decomposed in two stationary subsamples separated by a structural break, these tests seem to be biased to infer the presence of trend. In our case, specifically during the financial crisis that started in 2007 with greater repercussions in 2008, there is a sharp drop in the series of cumulative returns,

[6] See Bhar and Nikolova (2009).

suggesting the presence of a structural break. We consider this issue, incorporating the possibility of structural breaks in the stationarity tests, whose results are reported at panels B and C.

Following Evans (1989), Perron & Vogelsang (1991), Banerjee et al., (1992), Christiano (1992), Zivot & Andrews (1992), and Leybourne et al., (1998), we can assume that the breaks are associated with the extreme values of the asset return, so we should model them endogenously. There is also a second approach aligned with Perron (1989, 1990), Park & Sung (1994), Lütkepohl et al., (2001) and Saikkonen & Lütkepohl (2001, 2002), which analyzes this issue under the assumption of exogenous choice of the break points, according to some statistical criterion for identifying the date of break or due to an event considered as an exogenous relevant shock.

Therefore, as our main stationarity test, we perform follow Saikkonen & Lütkepohl (2002). First, we consider the break endogenously. Second, we identify it through the Chow test, according to Candelon & Lutkepohl (2001) and we use it exogenously. In all specifications, we include a constant and a trend. As a robustness check, we also perform them without the trend. Here, we do not report this latter result, although we discuss about it.

Cointegration, trends and cycles

Engle & Kozicki (1993) add to time series literature with a formal concept of common feature of the series of the system. Even though each of the series individually has the feature, there is at least one nonzero linear combination of these series that fails to have this feature. The feature is usually a data property such as serial correlation, seasonality, autoregressive conditional heteroskedasticity or kurtosis.

In order to study the level of financial integration based on this common feature approach, i.e., if their individual components are connected so they cannot move independently of one another in the long run, we may observe if our non-stationary series have the same order of integration and if they are cointegrated.

Aiming to evidence if the cumulative returns on BRIC main indices share a common stochastic trend, we need to identify the cointegrating vectors. Since we have $N = 4$ series in our system, there may be at most $r = 3 = N - 1$ linearly independent cointegrating vectors, which may be arranged in matrix given by $\boldsymbol{\alpha}_{(N\times r)}$, whose range is said the cointegration space. Among the methodologies of cointegration in a multivariate context, here we follow Johansen et al. (2000), which controls the effect of lagged variables, in addition to be robust to the insertion of an exogenous structural break.

Regarding the contagion effect, we follow methodologically Vahid & Engle (1993). According to them, an implication of the evidence of the serial correlation in the series in first difference as a common feature is the existence of common cycle in the series (in level). In our case, there can be at most $s = 3 = N - 1$ linearly independent cocharacteristic vectors, which can be arranged in matrix given by $\breve{\alpha}_{(N\times s)}$, whose range is said cocharacteristic space.

The framework

It is useful to represent non-stationary time series as consisting of three parts: a trend, a stationary component and a noise, which allows us to measure whether the stationary term smoothies or extends the long run deviations, besides identifying if the series are trend-stationary or whether they have a stochastic trend. According to Beveridge and Nelson (1981), we can decompose linearly the nominal cumulative return on each stock market index i in terms of the local investor´s currency, $R_t^i,\ t = 0, 1, 2, \dots, T$ as a sum of P_t^i and C_t^i. [7] In this decomposition, P_t^i is a permanent component, as a random walk with drift, whose intuition is related to long run forecasting of the trend adjusted series. The second term, C_t^i, is a stationary term, called transitory or cyclic, which consists of a linear combination of current and lagged residuals able to capture the short run effects of the respective stock market index. We can rewrite this decomposition as

$$R_t^i = P_t^i + C_t^i = P_{t-1}^i + \delta^i + \psi^i(1)\varepsilon_t^i + \psi^{*i}(L)\varepsilon_t^i \quad (1)$$

In this first relation, the terms that compose P_t^i are: δ^i, the trend's drift, $\psi^i(1)$, which represents the sum of parameters of lag operator L of asset i and ε_t^i, the residual of asset i at time t. The cyclic component is composed by $\psi^{*i}(L)$, a specific adaptation of $\psi^i(L)$, applied to residuals.

However, our purpose here is not analyzing an individual financial market, but a system of series of cumulative returns on main BRIC stock indices. In this case, it is usual to follow Stock and Watson (1988) who propose a matrix version of Beveridge and Nelson (1981) decomposition. So, we can revisit the relation (1), writing he following system:

$$\Delta \boldsymbol{R}_t = \boldsymbol{\delta} + \psi(1)\sum_{j=1}^{t}\boldsymbol{\varepsilon}_j \ + \psi^*(L)\boldsymbol{\varepsilon}_t \quad (2)$$

Here, $\Delta \boldsymbol{R}_t$ denotes an $N \times 1$ vector of cumulative returns in first difference, $\boldsymbol{\delta}$ is an $N \times 1$ vector of drifts, $\boldsymbol{\varepsilon}_j$ represents an $N \times 1$ vector of residuals at time j and $\psi(L)$ is a matrix polynomial in the lag operator L that can be decomposed linearly as the sum $\psi(1) + (1 - l))\psi^*(L)$. Based on this decomposition, regarding the long run relationship, if $\psi(1)$ has not full rank, there will be $r = N - k$ conintegrant vectors,

[7]There are several ways to decompose non-stationary series components in stationary and non-stationary components. However, the decomposition of Beveridge and Nelson (1981) draws particular attention to empirical studies of income, since the tendency as a random walk can be related to the concept of permanent income.

where k is the rank of $\psi(1)$. We can relate the common features in the short and long run, so that if there are r cointegrating vectors, and if $\psi^*(L)$ has not full rank, then there can be at most $s \leq N - r$ linearly independent cocharacteristic vectors.

These vectors can be identified, since columns of $\boldsymbol{\alpha}_{(N\times r)}$ e $\breve{\boldsymbol{\alpha}}_{(N\times s)}$ are the eigenvectors corresponding to zero and unit eigenvalues of $\psi(1)'$. [8] This procedure of identifying these vectors is based on the prior maximum likelihood estimation of the Vector Error Correction Model (VECM).

Finally, when there exist exactly r linear independent cointegrating vectors and $s = N - r$ linearly independent cofeature vectors, Vahid and Engle (1993) proofs that we can recover the trend and the cycle part of each BRIC return series. [9] In this case, matrix $\boldsymbol{A}_{(N\times N)} = \begin{bmatrix}\breve{\boldsymbol{\alpha}}' \\ \boldsymbol{\alpha}\end{bmatrix}$ has full rank. Partition the columns of its inverse accordingly as $\boldsymbol{A}^{-1} = [\breve{\boldsymbol{\alpha}}^{-} | \boldsymbol{\alpha}^{-}]$ and recover the individual trend and cycle decomposition as:

$$\boldsymbol{R}_t = \boldsymbol{P}_t + \boldsymbol{C}_t = \breve{\boldsymbol{\alpha}}^{-}\breve{\boldsymbol{\alpha}}'\boldsymbol{R}_t + \boldsymbol{\alpha}^{-}\boldsymbol{\alpha}\boldsymbol{R}_t \tag{3}$$

The permanent component of each stock market depends on cofeature vectors only, while the cyclic component depends on cointegrating combinations.

EMPIRICAL EXERCISE

Dataset and descriptive statistics

The main indices by trading volume and scope of composition of BRIC stock markets are the following:

i) IBOVESPA (São Paulo Stock Exchange Index, Brazil),

ii) SSE (Shanghai Stock Exchange Composite Index, China),

iii) SENSEX-30 (Bombay Stock Exchange Index, India) and

iv) RTS (Russian Trading System Index of Moscow, Russia).

Although in 2011 South Africa was included as a member, our analysis will be limited to the original formation.[10] In terms of time series, our sample consists of 155

[8] In this paper, we follow the Vahid and Engle (1993) procedure, using the routine proposed by Warne (2008).

[9] According to Proietti (1997), it is possible to extract the individual components even if $s = N - r$ fails to hold.

[10] During the Third Summit of the BRIC Countries, in 2011, South Africa was included as a member, bringing a name change to BRICS, even though this decision was essentially political since economically South Africa is not qualified for membership. According to the publication *BRICS Monitor* of April 25, 2011, South Africa has a GPD of US$ 350 billion, equal to some 20% of Russia's or India's, the countries with the smallest GPDs in the bloc, and a population of 50 million, only 33% that of Russia, the least populous BRIC country.

observations of net nominal monthly returns during the period from January 1998 to November 2010. Our main data source is CMA Trade.

A visual analysis of the graph of the cumulative returns of the indices in question (Figure 1) may suggest they have common long-term trends until the financial crisis. As of 2007, they start to have heterogeneous patterns, with the start of negative reactions to the crisis at different moments, with more or less accentuated cumulative declines and post-crisis reactions with distinct slopes and intensities.

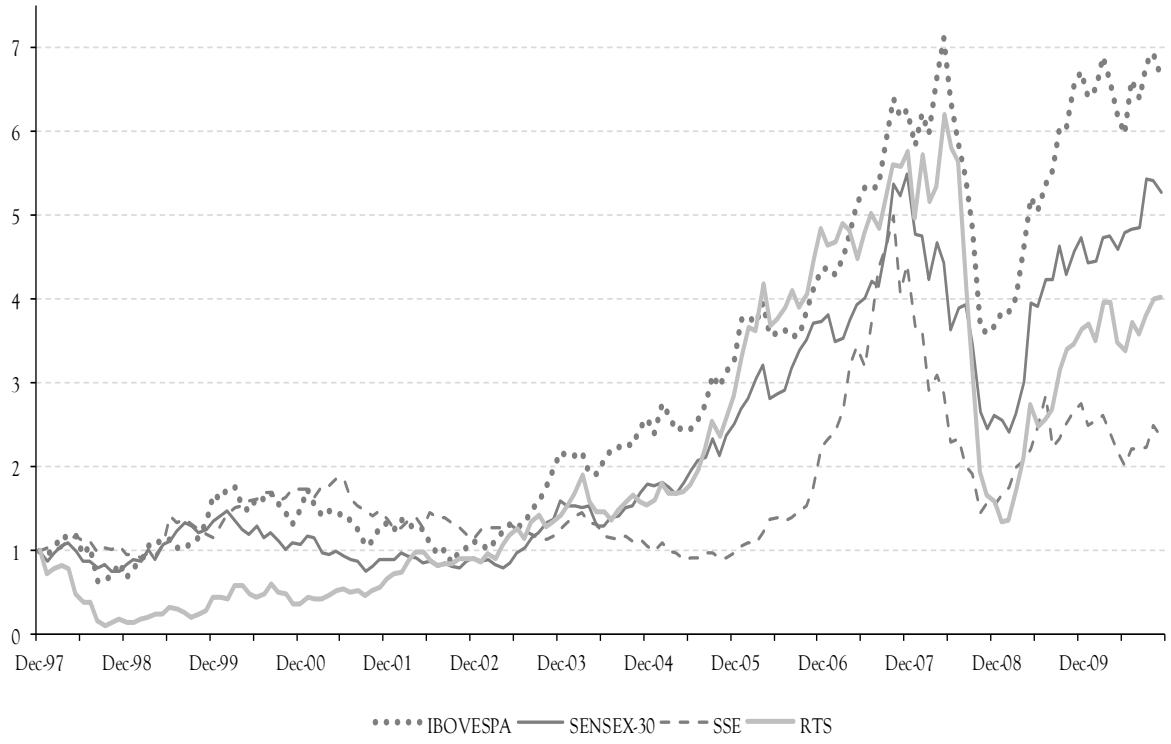


FIGURE 1. EVOLUTION OF THE RETURN ON THE BRIC STOCK MARKET INDICES [a, b]

[a] The figure plots the cumulative return on each stock market index in terms of the local investor´s currency, based on the monthly time series for the respective end-of-day quote, during the period from January 1998 to November 2010.

[b] The data source is CMA Trade.

The SSE index has separate behavior during the period from 2004 until the crisis, when it starts reacting before the other three indices, followed by the SENSEX-30. The Russian index shows a cumulative fall of 88.96%, much greater than the 51.62% of the IBOVESPA. After the crisis, the Russian index is also slower to start the recovery, but then does so more vigorously, rising by a monthly average of 5.61% as of January 2009, while the Chinese index's recovery averages 2.33%. Table 1 reports all these descriptive statistics of the indices.

The Brazilian index presents cumulative return of 564.04%, while the SSE only shows a gain of 136.18%. The Russian index presents the greatest absolute values of monthly rise and fall and higher values for all the risk metrics than the other three stock indices. The RTS has semivariance and standard deviation values that are roughly twice the respective ones for the Indian index, the SENSEX-30. Except for the Chinese index, the others are slightly skewed to the left and all show leptokurtosis, with the RTS having the greatest magnitude.

TABLE 1. BRIC STOCK MARKETS INDICES: SUMMARY STATISTICS OF THE RETURNS [a, b]

Statistic/ Stock market index		SSE	IBOVESPA	SENSEX-30	RTS
gain	minimum	-24.632%	-39.554%	-23.890%	-56.158%
	maximum	32.056%	24.046%	31.665%	55.981%
	cumulative	136.176%	564.035%	428.384%	302.497%
risk	standard deviation	8.539%	9.226%	8.001%	14.389%
	semivariance	5.983%	6.920%	5.785%	10.591%
	drawdown	70.968%	51.616%	56.171%	88.961%
other moments	asymmetry	0.103	-0.667	-0.064	-0.350
	kurtosis	4.417	5.044	3.825	5.427

[a] Statistics of the monthly returns on the each stock market index in termos of the local investor's currency, during the period from January 1998 to November 2010. [b] The data source is CMA Trade.

Analysis of stationarity and structural break

According to the usual stationarity tests proposed here (Table 2, Panel A), the series in question seem to be nonstationary, with a single exception: the Chinese index, based on tests proposed in Elliot et al., (1996), and Perron & Ng (1996). Based on these same tests, all four indices are stationary in first difference.

Aiming to deal with the possibility of regime change over time, we implement a statistical Chow test, so we can identify September 2008 as the only break, with instability before this date and stability after. According to the results reported in Panel C, when we incorporate this result in the framework of Saikkonen &

Lütkepohl (2002), or even considering an endogenous structural break (Panel B), we are able to corroborate the previous evidence: the returns on all BRIC stock market indices have a stochastic trend.

TABLE 2. BRIC STOCK MARKET INDICES: STATIONARITY TEST FOR THE CUMULATIVE RETURNS [a, b, c, d, e, f]

		IBOVESPA	RTS	SENSEX-30	SSE
Panel A: Traditional unit root tests					
Augmented Dickey-Fuller [b] (H_0: nonstationary series)	In level	-2.45 [0.35]	-2.84 [0.19]	-1.87 [0.67]	-2.98 [0.14]
	In 1st difference	-10.29** [0.00]	-6.26** [0.00]	-11.62** [0.00]	-6.40** [0.00]
Phillips-Perron (1988) [c] (H_0: nonstationary series)	In level	-2.45 [0.35]	-2.42 [0.37]	-2.21 [0.48]	-2.56 [0.30]
	In 1st difference	-10.40** [0.00]	-10.20** [0.00]	-11.74** [0.00]	-12.77** [0.00]
Elliott-Rothenberg-Stock (1996) [d] (H_0: nonstationary series)	In level	12.47	6.72	18.83	2.78**
	In 1st difference	1.35**	1.85**	1.28**	2.18**
Ng-Perron (1996) [e] (H_0: nonstationary series)	In level	H_0: No rejection	H_0: No rejection	H_0: No rejection	H_0: Rejection (1%)
	In 1st difference	H_0: Rejection (1%)	H_0: Rejection (1%)	H_0: Rejection (1%)	H_0: Rejection (1%)
Panel B: Unit root test taking into account endogenous structural break					
Saikkonen-Lütkepohl (2002) [f] (H_0: nonstationary series taking into account endogenous structural break)	In level	-1.85	-2.16	-1,83	-1,57
	In 1st difference	-10.88**	-5.70**	-11,32**	-4.64**
Panel C: Unit root test taking into account exogenous structural break					
Saikkonen-Lütkepohl (2002) (H_0: nonstationary series taking into account exogenous structural break in September 2008)	In level	-2.08	-2.28	-1.87	-2.95
	In 1st difference	-10.12**	-6.65**	-11.86**	-4.53**

[a] Unit root tests performed for cumulative return on each stock market index in terms of the local investor´s currency, during the period from January 1998 to November 2010. The data source is CMA Trade. [b] *t*-statistic reported with respective p-values in the box brackets. Lag lenth: Schwarz information criterion. [c] *t*-statistic reported with respective p-values in the box brackets. Bandwidth: Newey-West. [d] *P* statistic reported. Lag lenth: Schwarz information criterion. [e] Result reported conidering all modified tests: Mz_a, Mz_t, MSB e MP_T. Lag lenth: Schwarz information criterion. [f] *t*-statistic reported. Lag lenth: Schwarz information criterion. Shift function: shift dummy (In level) and impulse dummy 1[a] (1st difference). Critical values at 5% level: -3.03 (In level) and -2.88 (1st difference). * Indicates the rejection of the null hypothesis at 5% level. ** Indicates the rejection of the null hypothesis at 1% level.

Analysis of multivariate cointegration

In light of the equal order of integration, we analyze the multivariate cointegration aspect, based on the test proposed by Johansen et al., (2000). The result of this test, incorporating the structural break in September 2008 identified by the Chow test, utilizing one lag according to the Schwarz criterion and considering intercept and trend, indicates the existence of a single cointegration vector at the 5% level of significance, based on a trace statistic of 70.93. Besides identifying the rank of ψ(1), this methodology also allows us to estimate simultaneously, through maximum likelihood, the cointegrating vector, Z_t,[11]

$$Z_t = 1.00\,IBOV_t + \underset{(0.28)}{0.93}\,RTS_t - \underset{(0.44)}{2.69}\,SENSEX_t + \underset{(0.27)}{0.32}\,SSE_t + 0.64$$

as well as, the implied reduced-rank VECM,

$$\Delta IBOV_t = \underset{(0.03)}{-0.08}\,Z_{t-1} + \underset{(0.14)}{0.23}\,\Delta IBOV_{t-1} - \underset{(0.11)}{0.04}\,\Delta RTS_{t-1} - \underset{(0.15)}{0.10}\,\Delta SENSEX_{t-1} + \underset{(0.12)}{0.01}\,\Delta SSE_{t-1} - \underset{(0.07)}{0.11}\,dummy + \underset{(0.02)}{0.05}$$

$$\Delta RTS_t = \underset{(0.03)}{-0.11}\,Z_{t-1} + \underset{(0.14)}{0.60}\,\Delta IBOV_{t-1} + \underset{(0.11)}{0.00}\,\Delta RTS_{t-1} - \underset{(0.15)}{0.40}\,\Delta SENSEX_{t-1} - \underset{(0.12)}{0.19}\,\Delta SSE_{t-1} - \underset{(0.07)}{0.18}\,dummy + \underset{(0.02)}{0.04}$$

$$\Delta SENSEX_t = \underset{(0.03)}{+0.01}\,Z_{t-1} + \underset{(0.12)}{0.03}\,\Delta IBOV_{t-1} + \underset{(0.09)}{0.04}\,\Delta RTS_{t-1} + \underset{(0.13)}{0.04}\,\Delta SENSEX_{t-1} - \underset{(0.10)}{0.04}\,\Delta SSE_{t-1} + \underset{(0.06)}{0.05}\,dummy + \underset{(0.02)}{0.02}$$

$$\Delta SSE_t = \underset{(0.03)}{-0.02}\,Z_{t-1} - \underset{(0.11)}{0.07}\,\Delta IBOV_{t-1} + \underset{(0.09)}{0.04}\,\Delta RTS_{t-1} - \underset{(0.12)}{0.02}\,\Delta SENSEX_{t-1} + \underset{(0.10)}{0.02}\,\Delta SSE_{t-1} - \underset{(0.06)}{0.02}\,dummy + \underset{(0.02)}{0.02}$$

Individual trends and cycles

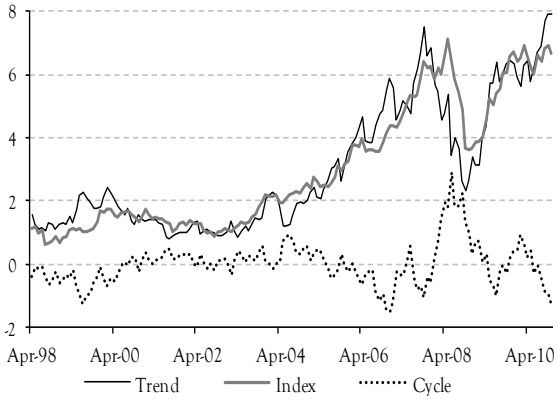
In Figure 2, we plot the evolution of the decomposition into cycle and trend for each stock index.

The comparison of the cumulative return on stock market series and their respective individual cycles and trends allows us to infer that during the period of relative international stability, between 2000 and 2006, BRIC financial markets were driven by the trends instead of cycles, i.e., they were driven by economic fundamentals instead of global or local financial risk drivers.

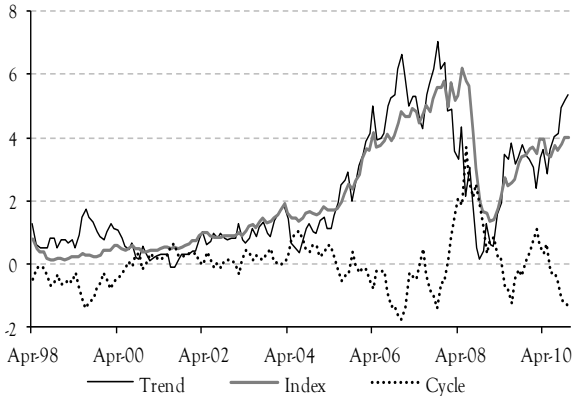
However, in 1999, after the Russian crisis and during the Brazil problem with exchange rate, idiosyncratic reactions of BRIC stock indices, characterized by individual cycles, have greatest magnitude (predominantly negative), even when compared with reactions during the recent global crisis.

[11] In our normalization, the IBOVESPA parameter is unitary.

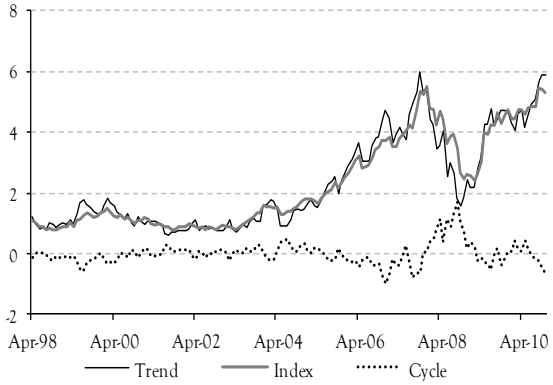
In the period preceding the start of the most recent crisis, in 2007, in all financial markets there are two distinct and evident periods of successive negative shocks, whilst during the turbulent year of 2008, there are essentially positive cycles, with high values, comparable to those obtained for the respective trends. The post-crisis period is characterized by negative and positive cycles. IBOVESPA and RTS indices show the most volatile cycles, with extremes of greater magnitude.



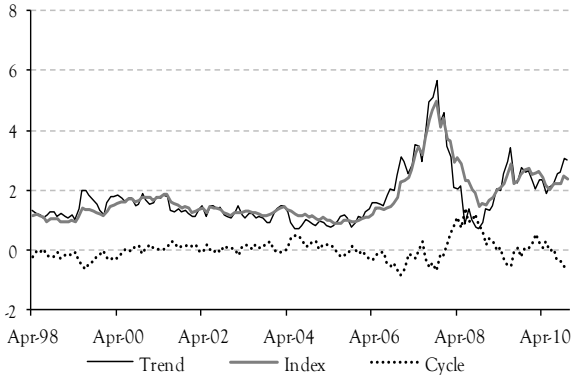
2.a. IBOVESPA



2.b. RTS



2.c. SENSEX-30



2.d. SSE

FIGURE 2. EVOLUTION OF THE CUMULATIVE RETURNS AND OF INDIVIDUAL TRENDS AND CYCLES OF BRIC STOCK MARKET INDICES[a]

[a]The methodology used to identify individual trends and cycles takes into account the structural break identified in September 2008.

Common trends

According to Matos et al. (2011), over the period from 1998 to 2007, the first of the three convergence clubs considering cumulative returns is composed of stock indices in economies classified as emergent or developing, with highlight on the presence of three of the four BRIC countries. China market is the exception. Other previous evidences of partial or full integration in BRIC, based on exercises with macroeconomic or financial variables, are reported in Bai (2009), Misra & Mahakud (2009), and Chittedi (2010), among others.

These studies have a common aspect: they used to cover a period characterized by local financial crisis only. Here, we go a step further in this discussion: BRIC are financially integrated end establish a mutual relationship of long-term financial equilibrium based on three common stochastic trends (Figure 3), an evidence robust to a structural break identified due to the recent global crisis, in 2008.

As can be seen, the evidence of three common trends, distinguishable mainly as of 2004, suggests that over the long run we can consider three scenarios in sample and for the next decade, if the 1998/2010 outlook were to be repeated, even it seems to be highly unlikely.

Common trend #1 reflects a possible converging trajectory for BRIC financial markets, following the similar behavior of the respective indices throughout the period, but more extremely, as a signal of continuance of the recovery path after the 2007 financial crisis. However, BRIC can follow negative risk drivers still incorporating the effects of the recent crisis, without recovery of these stock markets, which follow two possible and very close common trends, #2 and #3.

Regarding the individual trends, they seem to be mutually comparable. Until the crisis, the indices' trends are moving together, with a smaller detachment only for the Chinese index, as we have observed in the evolution of the cumulative returns (Figure 1). The trend of the SSE is the least volatile and shows the lowest average trend, 1.72, while the other indices' average trends are greater than 2.00.

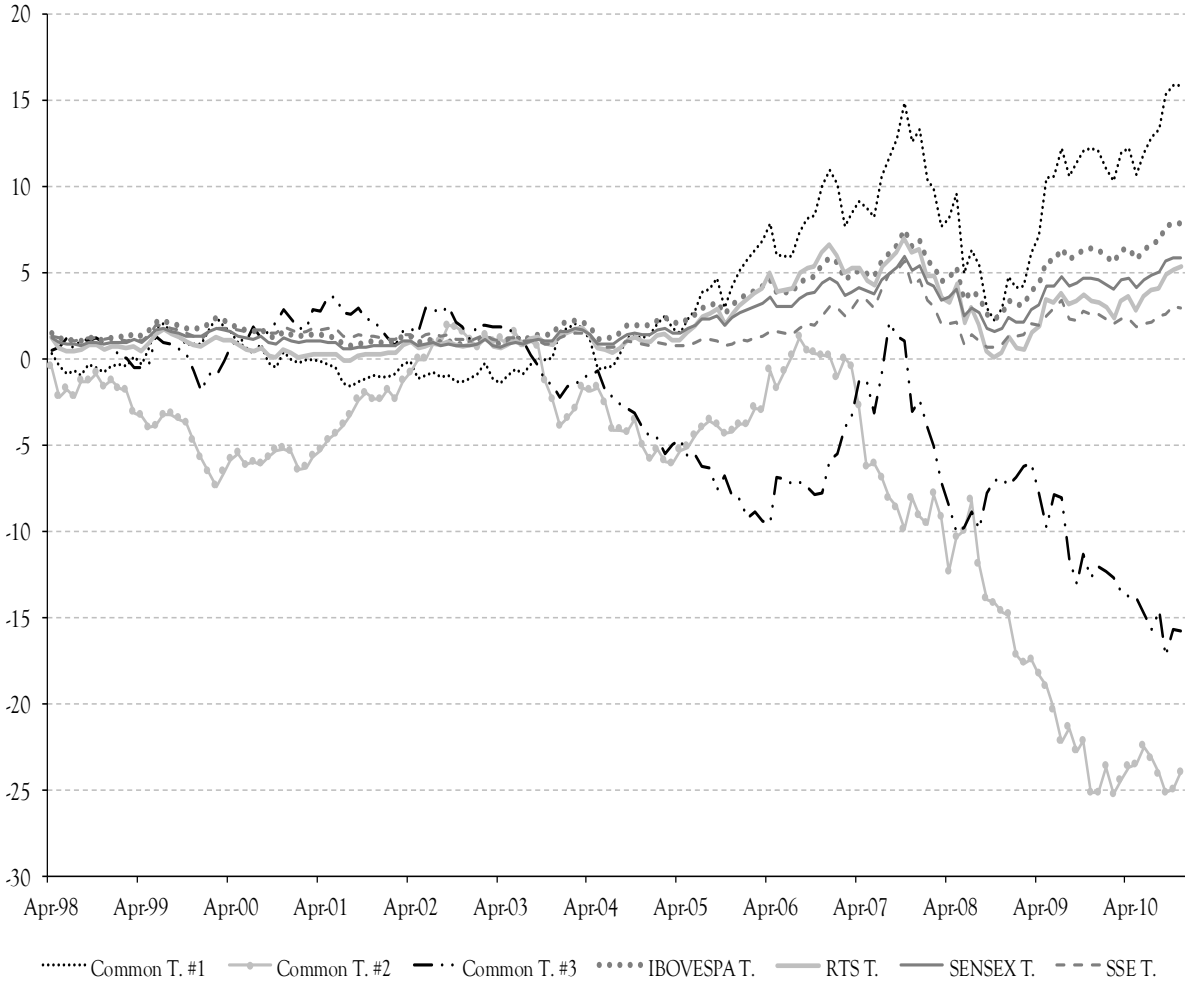


FIGURE 3. EVOLUTION OF THE INDIVIDUAL AND COMMON TRENDS OF BRIC STOCK MARKETS INDICES[a]

[a]The methodology used to identify individual and common trends takes into account the structural break identified in September 2008.

Common cycles

Aiming to evidence if the hypothesis of contagion holds, we test for the existence of common cycles taking into account the break in September 2008. Based on a likelihood ratio statistic of 12.116 in a test with 12 degrees of freedom, the null hypothesis of having at least one common cycle in BRIC countries cannot be rejected at 5% significance. We report the individual cycles and the unique common cycle in Figure 4.

The individual and common cycles are perfectly comparable. They seem to have similar patterns over time, with the common cycle being less volatile than the individual ones. All the indices of these emerging economies shift away from their respective trends more negatively in December 2006, before the financial crisis. Considering only turbulent periods, the Brazilian and the Russian indices react more

intensively during the own crisis in 1998-1999, while the Indian and the Chinese economies are more negatively influenced by deviations during the global crisis.

The highest positive shocks occur in June 2008, with highlight in both cases for the RTS index, with larger negative and positive cycles. The Russian values are substantially greater than the extremes of the other individual cycles and the common cycle and are comparable only to Brazilian cycles.

FIGURE 4. EVOLUTION OF THE INDIVIDUAL AND COMMON CYCLES OF BRIC STOCK MARKETS INDICES[a]

[a]The methodology used to identify individual and common cycles takes into account the structural break identified in September 2008.

Consequently, the Russian index has the most volatile individual cycle, followed by the IBOVESPA, both being more volatile than the common cycle. The Chinese and Indian indices present the most stable behaviors in terms of cycles, including when compared to the common cycle. We present cycles statistics in Table 3.

TABLE 3. BRIC STOCK MARKET INDICES: INDIVIDUAL AND COMMON CYCLES[a, b, c, d]

Panel A: Correlation between common and individual cycles

Cycles	Common	IBOVESPA	RTS	SENSEX-30	SSE
Common	1.000				
IBOVESPA	0.832	1.000			
RTS	0.831	0.992	1.000		
SENSEX-30	0.551	0.921	0.914	1.000	
SSE	0.759	0.988	0.981	0.956	1.000

Panel B: Summary statistics of common and individual cycles

Cycles	Common C.	IBOVESPA	RTS	SENSEX-30	SSE
mean	-0.004	1.316 e -08	1.316 e -08	-1.461 e -17	1.974 e -08
standard dev.	0.394	0.681	0.809	0.368	0.357
minimum	-0.868	-1.525	-1.768	-1.002	-0.854
maximum	1.954	2.917	3.684	1.675	1.422

Panel C: Granger causality between common and individual cycles

Causality	IBOVESPA	RTS	SENSEX-30	SSE
Common cycle ⇒ Index	F = 1.264 [0.263]	F = 3.581 [0.060]	F = 8.683* [0.004]	F = 1.535 [0.217]
Index ⇒ Common cycle	F = 5.038* [0.026]	F = 2.996 [0.086]	F = 4.761* [0.030]	F = 6.203* [0.014]

Panel D: Granger causality between individual cycles

Causality	IBOVESPA	RTS	SENSEX-30	SSE
IBOVESPA		F = 6.426 [0.012]*	F = 8.435 [0.004]*	F = 0.860 [0.355]
RTS	F = 0.177 [0.675]		F = 8.810 [0.004]*	F = 1.471 [0.227]
SENSEX-30	F = 1.277 [0.260]	F = 0.707 [0.402]		F = 1.270 [0.262]
SSE	F = 0.144 [0.705]	F = 1.797 [0.182]	F = 9.571 [0.002]*	

[a] Statistics of the monthly series of common and individual cycles, during the period from April 1998 to November 2010. [b] The correlations reported are uncentered. [c] The Granger causality test uses only one lag. Respective p-values are reported in the box brackets. [d] At Panel D, each entry referes to the result of the Granger causality of the respective row indice on each columm indice. * Indicates the rejection of H_0 (no Granger casuality) at 5% level.

Based on the statistics (Panel A) the cycles of all indices are positively and robustly correlated, which suggests that the direction of the short-term movements caused by

transitory shocks is the same in the four indices, but with different intensities. In terms of predictive power, our procedure based on Causality tests between cycles is quite similar to Gray (2009). The analysis of the individual cycles (Panel D) suggests possible paths to be trailed by the contagion effect in BRIC. The Brazilian and the Chinese stock markets seem to be the first ones to react to global shocks, so that they are able to predict the common short run deviations and the Indian individual cycles.

Regarding the causality tests involving the common cycle (Panel C), the Russian market, whose individual cycle can only be predictable by the Brazilian cycle, is the unique useless to predict the common cycle.

Finally, we need to mention that the series used here do not address the question of exchange rate risk, but rather consist of the evolution of the aggregate market value of the main listed companies of each of the countries, from the perspective of the respective local investors. Hence, these results should not be used for making inferences on international diversification, but rather should be taken as a contribution to the discussion on financial integration and contagion.

DISCUSSION

We identify the Brazilian and Chinese financial markets, as capable to exert relatively higher influence in the short run. We claim that worldwide investors should consider reactions in those markets during crisis as a predictor of other BRIC reactions through the contagion channel, while policy makers should attempt to the level of contagion observed here, given its relevance when evaluating the effectiveness of interventions and financial assistance packages after crisis. But, what these markets have in special?

Any explain for an influence exerted by China is obvious, since this country is in the top five world ranking for trade in services or merchandise, considering export or import, is the largest trade partner for each of the other BRIC, has the highest average yearly GDP growth rates during the period from 2001 to 2010, 10.5%, and its market capitalization size accounts for more than US$ 5.6 trillion in 2010.

The numbers for Brazilian economy are more unpretentious. Brazil has the second higher level of net foreign direct investment flow in 2010, US$ 36.9, lower than Chinese level, according to Mathur & Dasgupta (2013). Observing data of trade intra-BRIC, this economy is the second most relevant trade partner for rest of the BRIC, with a trade share of 24.3%. Under a financial perspective, the annual trade volume of US$ 800 billion in BMF & Bovespa is the second in the rank of BRIC main stock exchanges, lower than Shanghai Stock Exchange level, only and its index, IBOVESPA, presents the highest cumulative return of 564.04%, from 2001 to 2010.

The Russian financial market, like a strange in the nest, also deserves our attention, since we fail to reject the null hypothesis in most Granger causality tests involving RTS index. This is the lowest market in terms of capitalization size, based on absolute and also relative values and the annual volumes in Moscow Exchanges are also the inferior limit comparing to other BRIC stock exchanges.

In the long-run, the evidence about three common scenarios suggests that BRIC financial markets are linked, even in an environment where we still do not observe a higher and desirable level of harmonization of respective stock markets with the international rules and regulations. In other words, they need to institute new regulatory frameworks concatenated within the bloc and they still should care about the inefficient government bureaucracy, corruption and inflation. As emphasized in Chittedi (201): "[…] Financial integration is key to delivering competitiveness, efficiency and growth. But will integration also bring about financial stability? Not necessarily. Strong framework rules, closer cooperation and in particular a readiness to share information and coordinate action across borders are necessary complements."

In general, these reforms and liberalization initiatives depend on the removal of government monopolies, measures to increase domestic competition and policies capable to attract foreign portfolio flows. More specifically, China is reforming laws to foster stock market development and promote substantial liberalization in the financial sector, while in India, reforms have been introduced since 1992 in order to promote private sector competition, because the financial services used to be dominated by state owned companies.

A similar scenario can be observed in Russia, which is implementing a gradual privatization of banking system. In Brazil, because of liberalization, among the top 50 banks, 20 are foreign controlled private banks (See Mathur & Dasgupta, 2013 for further information about reforms in BRIC financial services).

This result could also motivate a globalization intra-bloc in terms of alliances of the respective stock market exchanges. Together, this bloc market capitalization is of US$ 10.5 trillion in 2010, which is higher than the volume of any G7 economy, except USA. Instead of an intra-bloc alliance, what we can observe in a recent historical of globalization is the merging involving derivatives and stock exchanges in a same country, as the Brazilian experience in 2008, or alliances as the entering process of BATS Global Markets in the Brazilian market.

Stronger securities market provides the internationalization of an economy by linking it with the rest of the world, which is essential for BRIC economies, whose levels of market capitalization are lower than 80% of the respective GDP's, except for India. We could also expect a cross-border capital flow increase as well as a more representative presence of Indian companies with stock listed in other BRIC stock exchanges, for example.

It is also relevant in order to raise the levels foreign direct investment intra-bloc and involving other economies. The share of BRIC economies in global FDI flows in 2010 is 17.7% and 11.0%, considering inflow and outflow respectively. A key element in this purpose is strengthening the presence of BRIC financial firms around the world, which seems to be implemented by Chinese and Brazilian banks more intensively. We may also expect an increase of the bloc's importance in trade scenario, since this bloc accounts only for 9.4% and 12.0% of worldwide export and import, respectively (See Guell & Ricahrds, 1988 for an evidence about the relation between integration and trade in Latin America).

CONCLUSION

When an ad hoc acronym is coined by financial market, researchers use to analyze if there are fundamentals to support such creation and then suggest to policy makers how take this kind of opportunity in order to improve social welfare. This is what we do here: we infer how appropriate in financial terms is the use of BRIC, which enables us to support policy makers' decisions. This a relevant and nonconsensual issue to be addressed, because for one side, BRIC has common features identified in the literature, but for the other side, BRIC economies have heterogeneous profiles in terms of the cultural, political, social, demographic and macroeconomic contexts, or also observing human capital and labor market variables.[12]

In this controversial context, our main findings corroborate previous studies suggesting that their main stock market indices share short- and long-run equilibrium relationships, thus indicating that there seems to exist high levels of integration and contagion of BRIC financial markets.

To summarize, everyone knows that financial markets are already looking for the next BRIC countries and there is no shortage of candidates. Therefore, if BRIC economies still desire to attract the attention of investors, researchers and policy makers, their integrated stock markets may play an imperative role to contribute to both capital accumulation and technological innovation. Only in this way, by 2020, in a scenario of economic growth and considering inflationary effects, this block will account for a third of the global economy (in PPP terms) and contribute about a half of global GDP growth. Otherwise, even Jim O'Neill, who coined this acronym, will advocate that BRIC economies should be included in an expanded G7.

[12]According to Wilson and Purushothaman (2003), macroeconomic, institutional, financial-commercial openness and educational factors need to be improved for the BRIC nations to meet their projected growth levels. Bell (2011) indicates that common aspects continue being a hindrance to the development of the bloc's countries: inefficient government bureaucracy, corruption and inflation, among others.

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