

# An analysis of fixed income BRICS markets

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## Abstract

In this paper, we examine the performance of the BRICS bond markets, trying to evaluate whether these markets can represent a profitable investment for non-satiable and risk averse investors. First, we analyze the main statistical characteristics of the returns in each of this markets. Then, we propose an empirical comparison of profitability of investment strategies among the BRICS markets. Specifically, we compare the ex-post sample paths of the wealth, obtained investing in the bond BRICS markets, following the classical theory according to Fisher and Weil immunization theory. Moreover, we also evaluate the portfolio investments based on Inflation-Linked Bonds of these emerging markets.

## Key words

Portfolio optimization, BRICS markets, Sharpe performance.

**JEL Classification:** C44, G11, G15

## 1. Introduction

In the last years, within the Emerging Markets Economies (EMEs), the specific group of emerging countries named BRICS<sup>2</sup>, have achieved, a significant economic growth. In fact, either during the pre-crisis (pre 2007), that during the global financial crisis, Brazil, Russia, India and China have reached higher performances than European and US markets (see [8] and [16]). Just in view of their similar economic and financial characteristics it is possible to consider the mentioned four countries as a single group; therefore, the decision to involve South Africa in the BRICS countries represents an evolution of the classical concept of BRIC's, and the reasons of this inclusion could be sought in the role that this country plays in the sub-Saharan region and in the wide availability of natural resources, highly developed infrastructures and financial facilities with a consolidated banking system to support.

In general, the strong growth registered by the BRICs markets in recent years, together with their surprising independence from the developed economies, (especially during the financial crisis), followed by the appearance of South Africa on the BRICS economic and financial horizon, have created many opportunities for the financial investors.

In this paper, we examine the BRICS bond financial markets and we evaluate their portfolio performance comparing the ex-post wealth obtained optimizing the Sharpe ratio. In particular, we refer to the time series of bonds prices in the BRICS markets using data from the provider Thomson Reuters DataStream, starting from 2012 for Brazil data and from 2005 for other BRICS countries. For every country, we first consider a fixed duration value, to create a series of optimal (artificial) funds in which to invest. Then, we optimize the portfolios previously created, in order to determine which performance would have been obtained by

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<sup>2</sup> The term BRIC's, coined for the first time in the 2001 by O'Neill in [13], was used at the beginning to indicate four countries: Brazil, Russia, India and China. Afterwards, the acronym became BRICS (with capitol S) in order to include also the South Africa.

investing in these markets over the last decade, following the classical theory according to Fisher and Weil and optimizing according to the methodology suggested by Sharpe (i.e. using the Sharpe Ratio). Moreover we include in the optimization problem also the Inflation Linked Bonds, in the case of Brazil and South Africa (the two countries that present a sufficient number of these particular class of bonds).

The paper is organized as follows: in Section 2 we briefly examine the main features of BRICS financial markets and their bond returns. In Section 3 we describe the portfolio selection problem. In Section 4 we propose the ex-post empirical analysis applied to the BRICS bond markets.

## 2. Main features of BRICS financial markets

The markets deregulation and globalization with consequently consolidation process in the banking sector, along with the Information Technologies development, have made the BRICS highly attractive for both local and foreign investors. In fact, despite the persistence of some problem, like the significant shortage of investors who regularly invest in these markets<sup>3</sup>, or the problem known as "shortage assets phenomenon"<sup>4</sup>, the number of foreign investors operating in the BRICS markets is increasing. However, in both cases, local and foreign investors, the institutional investors are more frequent than retail and in most cases, their operations are limited to the traditional investment and does not include the creation of innovative financial products (see [16]).

The main Stock Exchanges currently operating in the BRICS countries, are: the BM&FBovespa in Brazil, created in 2008 from merge of São Paulo Stock Exchange (Bovespa) and the Brazilian Mercantile and Futures Exchange (BM&F); the Moscow Exchange in Russia, created in 2011 from Moscow Interbank Currency Exchange and Russian Trading System (RTS); the Bombay Stock Exchange (BSE) and the National Stock Exchange (NSE) in India; the Inter-bank bond market regulated by People's Bank of China (PBoC), and the Exchange bond market regulated by China Securities Regulatory Commission (CSRC) in China; finally, in South Africa, the Johannesburg Stock Exchange Limited (JSE Ltd).

We analyze the characteristics of bonds representing the sovereign debt in each BRICS country, considering the data from the provider Thomson Reuters DataStream.

Regarding the securities issued in Brazil from 1989, they are classified in conventional bonds, themselves consist of straight bonds (33%) and zero-coupon bonds (67%), and Indexed Bonds (principally Inflation Linked Bond, hereafter ILBs). About Russian market, we consider the data from 1989 observing that public debt bonds are not present the indexed bonds, but only the classic securities made up by straight bonds (82%) and Zero Coupon Bonds (18%). The data of Indian public debt are available from 1971 and refer to Government securities and corporate bonds. The Indian market is composed only of classic bonds divided almost equally into straight (52%) and type Zero Coupon Bond (48%). Even the Chinese government debt is mainly composed of government bonds (issued from 1950); similarly to the Indian market, we observe the presence of classics bonds only: straight bonds for a percentage of 94% and Zero Coupon Bonds for the residual 6%. Finally, like in the case of Brazilian public debt, the South Africa has either classic bonds either Indexed Bonds (principally ILBs). The conventional bond section is composed by 48% of Straight bonds and 52% of Zero-Coupon bond.

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<sup>3</sup> In fact, the so-called cross-over investors also operates in different markets and this behavior determines an "on-off" access resulting in an assets prices volatility (see [5]).

<sup>4</sup> i.e. the lack of securities issuance that determines some distortion effects, like the so called "buy-and-hold investment strategy" that makes illiquid these markets (see [4] and [17]).

As already mentioned, the Inflation linked bonds are an important share of the public debt of Brazil and South Africa. The ILBs are bonds that provide protection against inflation, i.e. the risk from unexpected change in the consumer price index. Specifically, an inflation-linked bond (ILB) is a bond whose coupons are linked to a consumer price index. An inflation swap is a contract between an inflation "receiver" who pays a fixed rate versus an inflation-indexed rate (floating or fixed); the inflation "payer" pays the indexed rate. The swap agreement defines the dates when the cash flows are to be paid and the way they are calculated. Usually at the time when the contract is initiated at least one of these series of cash flows is determined by a random variable.

Several studies indicate the reasons why governments should issue ILB's (see [2], [3], and [12]) and recent studies propose the corporate inflation-linked bonds, as an appropriate substitute for sovereign inflation-linked bonds (see [11]).

The reason why private investors should benefit from the availability of ILBs are principally that ILBs may provide the most natural hedge against the risk of inflation; therefore, since inflation is uncertain, there may be benefits in terms of portfolio diversification (see [6]) is that the diversification benefits for holders of ILBs allows a positive inflation risk premium. Several empirical analyses have supported this point in the US inflation-linked bonds (see, among others, [7], [9], [14]) and in the Euro zone (see [1]).

In this paper, we evaluate the profitability of the investment strategies in each of BRICs markets, considering both sovereign and corporate bond for all BRICS countries and ILBs, for Brazil and South Africa.

### 3. Portfolio selection model

The portfolio selection problem is traditionally studied in terms of reward and risk of the underlying portfolio. However, since we deal with both sovereign/corporate and inflation linked bonds, we have to take into account that the concept of reward and risk nominal bonds or for ILBs and is different.

When we deal the portfolio problem with corporate or nominal bonds the measure of reward is represented by the yield to maturity and/or the portfolio future wealth that we get with the product between wealth and the yield to maturity. Therefore, a proper risk measure is represented by the modified duration of the portfolio. Thus we can assume that investors maximize their portfolio future wealth for a fixed portfolio modified duration. Otherwise, when we consider the index-linked bonds, we are not generally able to determine the yield to maturity and the modified duration, then we cannot use these measures of reward and risk for these bonds. In this case we have to use a reward-risk portfolio approach where the reward and risk measures are estimated on the historical observations of ILB returns as for the classical mean-variance analysis proposed by Markowitz (see [10]).

Therefore, considering a market in which no short selling is allowed we can distinguish the two following reward-risk approaches.

#### 3.1 Portfolio problem with sovereign and corporate bonds

Consider  $r = [r_1, \dots, r_n]'$  the vector of the yields to maturity of the assets,  $D = [D_1, \dots, D]'$  the vector of the modified durations of each nominal bond, and  $v = [v_1, \dots, v_n]'$  the vector of the wealth invested in the bonds i.e.  $v_i = y_i P_i$  where  $y_i$  is the number of assets invested in the  $i$ -th bond and  $P_i$  is the price of the  $i$ -th bond. Then we can assume that the portfolio modified duration is approximated by the formula:

$$D_{(v)} = \frac{v' D}{\sum_{i=1}^n v_i}$$

Thus investors in a reward-risk framework should maximize the expected future wealth approximated by  $v_i (1 + r)$  for some fixed risk represented by the modified duration of the portfolio  $D_{(p)}$  and investors will choose a solution of the following optimization problem:

$$\begin{aligned} & \max_y v_i (1 + r) \\ \text{s. t. } & \sum_{i=1}^n y_i P_i = W; \quad \frac{v'D}{W} = d; \\ & y_i P_i = v_i; \quad y_i \geq 0; \quad i = 1, \dots, n \end{aligned}$$

for some fixed modified duration  $d$  and an initial wealth  $W$ . In this optimization problem we do not need historical observations of bond returns to estimate the reward and risk measure.

### 3.2 Portfolio problem with Inflation Linked Bonds

Given a benchmark with return  $r_b$  and  $n$  index linked bonds with a vector of returns  $r = [r_1, \dots, r_n]'$ , the classical portfolio selection problem in the reward-risk framework consists of minimizing a given risk measure  $\rho$  provided that the expected reward  $v$  is constrained by some minimal value  $m$ . Along the efficient choices obtained by varying the value of the constraint  $m$ , there is a portfolio (commonly referred to as the market portfolio) that provides the maximum expected reward  $v$  per unit of risk  $\rho$ . So, assuming that the reward and risk are both positive, the market portfolio is obtained as the solution to the following optimization problem:

$$\begin{aligned} & \max_x \frac{v (x'r + r_b)}{\rho (x'r + r_b)} \\ \text{s. t. } & x_i \geq 0 \quad \forall i; \quad \sum_{i=1}^n x_i = 1 \end{aligned}$$

where the vector notation  $x'r = \sum_{i=1}^n x_i r_i$  stands for the returns of a portfolio with composition  $x = [x_1, \dots, x_n]'$ , and the no short selling assumption is represented by  $x_i \geq 0 \quad \forall i$ . Starting from the original Markowitz' analysis, Sharpe suggested that investors should maximize the so-called Sharpe ratio (see [16]) given by:

$$SR(x'r) = \frac{E(x'r + r_b)}{STD(x'r + r_b)}$$

In the Sharpe ratio, risk is a proxy of the standard deviation  $STD(x'r + r_b)$  of excess returns. Therefore we use historical observations of returns to estimate a reward and a risk of the portfolio return and we evaluate the portfolio performance with a measures typically used to evaluate the choices in the stocks markets.

### 3.3 Portfolio selection problem

Due to the different availability of the data in the different BRICS, we consider the data of Brazil from 26 October 2011 to 27 April 2015 (915 observations) and for Russia, India, China and South Africa the data from 11 May 2005 and 27 April 2015 (2600 observations). As the number of observation we mean the number of the days contained in the whole period. For each bond, we consider the adjusted prices sourced by the provider Thomson Reuters DataStream.

Considering the portfolio problem with sovereign and corporate bonds, we can distinguish two phases (including the transaction costs) for the portfolio decisional process referring two different sources of risk: the risk of variation of the prices and the market risk.

1. In the first phase we compute the ex post wealth we obtain optimizing the expected future wealth of the portfolio of bonds taking into account the risk of variation of the prices fixing the portfolio modified durations. The modified duration is prefixed and recalibrated every 20 days, where the initial portfolio will be updated. Thus in this first phase we create a fund of bonds for any fixed modified duration. The funds change in their composition periodically to maintain the constraint of the fixed duration. In this phase we refer to the optimization problem of Section 3.1, therefore we do not need historical observations of bond returns to estimate the return and risk measure.
2. In the second phase of the portfolio decisional process we use as historical series the ex-post wealth we obtain in the first phase for different modified duration. Then we optimize the Sharpe ratios on these series. With this second phase we practically reduce the market risk considering the observations of the ex post wealth obtained with each fixed modified duration as the prices of a fund built in Phase 1. Then we perform a return-risk portfolio optimization for different modified duration.

#### **4. Empirical results**

In this Section, we compare the ex-post wealth obtained in each BRICs countries, using the optimization methodology based on Sharpe Ratio. Therefore, we show the performance that would have achieved by investing an initial wealth of 1 (on average) in the BRICS bond markets, in the last ten years, according to second phase of the portfolio decisional process presented above. Specifically we show the results obtained by optimizing the portfolio, composed of 20 optimal funds created in the first phase, according to the classic immunization. In this analysis we use the Sharpe measure (applied to daily time series of 125 trading days) in order to reduce the market risk, regardless of the average duration of bonds considered. However we increase the frequency of recalibration (that was monthly in the first phase), reinvesting the wealth weekly, to approach the standard practice of the stock market.

Figure 1 shows the returns' evolution in the Brazilian bonds markets. In the short term there is a low level of returns due to high market volatility. Follows a positive trend up to 2013, where there is a new fall, with values of wealth similar to the initial amount. Then a new positive trend occurs up to 2014, only interrupted by negative variation at the end of 2013. During 2014 is logged a period of high volatility, probably due to the economic crisis of the country, which is reflected on a greater uncertainty in the bond markets. In 2015 the markets seems to overcome the previous difficulties, in fact the wealth records a positive variation, reaching 1,1 times of the initial amount invested.

Figure 1: Ex post wealth on Brazilian bond market

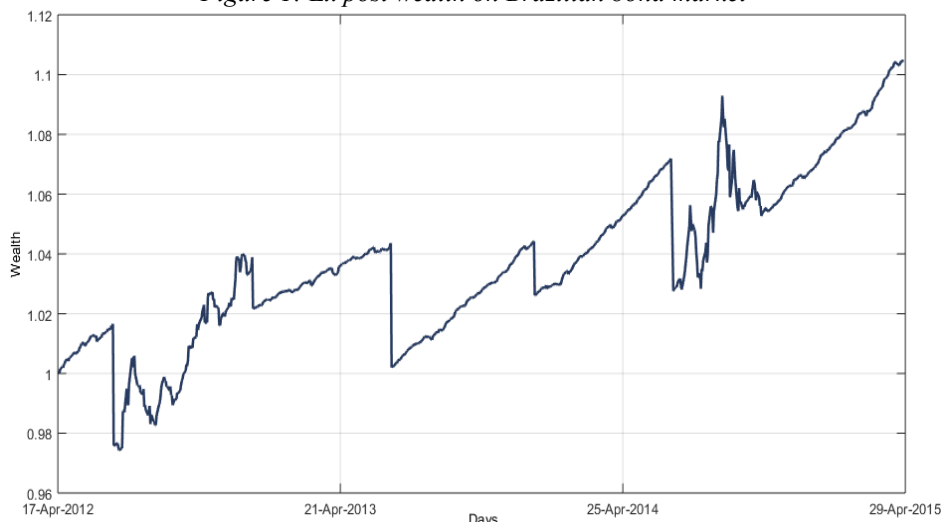


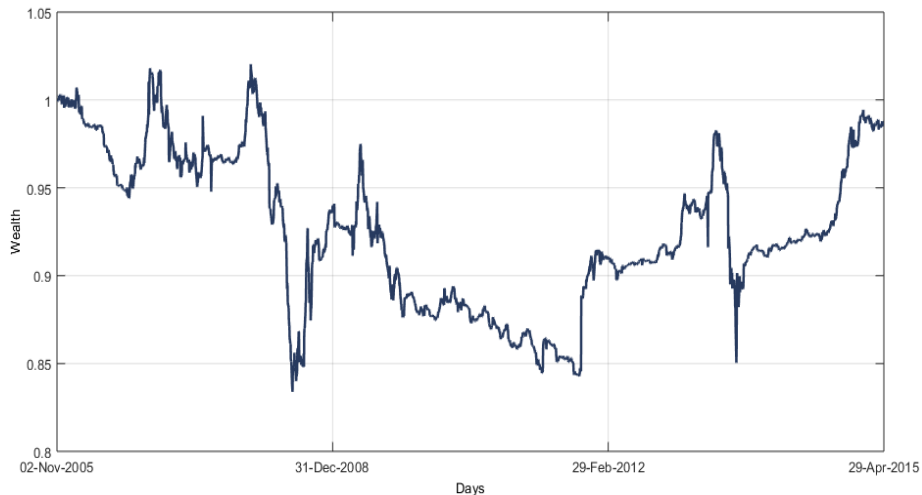
Figure 2 shows the wealth evolution in the Russian bonds markets, obtained used the Sharpe ratio, that appears consistent with immunization method used above. In fact, we observe a constant value of wealth in the first period (up to July 2008). Afterwards, the chart shows a reduction of the returns (up to -0,35 of the initial invested value) due to the effect of the global crisis and a brief recovery period, until the "gas crisis"; this latter is reflected in a notable fall, with a minimum registered in December 2010, where the wealth is 0.9 times the initial value. After that, we observe a positive trend with a maximum gain registered in the last years (3,5 times the invested wealth).

Figure 2: Ex post wealth on Russian bond market



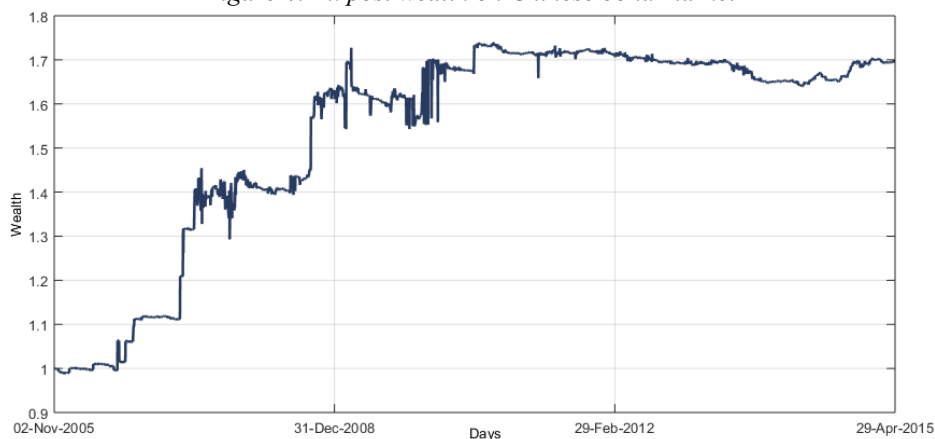
As showed in the Figure 3, the Indian bond markets holds securitized with securities with a high rate riskiness and volatility reflected in a fluctuating evolution of returns. The peak of the loss is logged in August 2008 (during the financial crisis), period characterized by a strong negative trend of returns and negative variations up to -0.16 times the initial amount invested. With some exceptions, the trend remains negative until early 2012. In the following period, it records a weak signs of recovery, which is arrested by a new collapse in August 2013 (when the exchange Indian currency/dollar reached an new minimum). From 2013 is logged a new weak increasing of the returns stem from Indian sovereign and corporate bonds.

Figure 3: Ex post wealth on Indian bond market



China is the country in which we observe the higher returns in term of evolution of invested wealth. In fact, as showed in Figure 4, there is a constant increasing trend (interspersed with jumps still positive) of the returns, over all the horizon considered. Also during the global financial crisis, although we observe a certain volatility, the gains are never gone below 1.5. Nevertheless, during the 2010, this positive trend suffers a setback, and it is followed by a weak flexion during the 2012.

Figure 4: Ex post wealth on Chinese bond market



Finally we show the trend of wealth in South Africa bond markets, in Figure 5. Invested wealth has a cyclical evolution characterizing by the alternance of gain and loss steps. From 2010 there is a turnaround leading to an increase in performance, with positive returns of 0.3 times higher than the initial fortune. From 2013 to the beginning of 2014 there is an unusual evolution of wealth, due to economic problems inside the country. After that it is recorded a positive trend, up to the end of the considered time horizon.

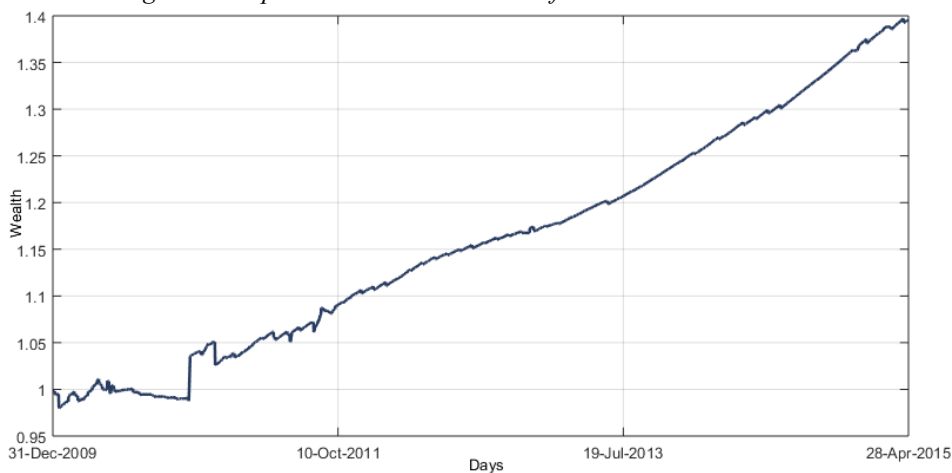
Figure 5: Ex post wealth on South Africa bond



In our analysis we consider also the portfolio optimization consisting of only inflation-linked bonds issued in the Brazilian and South African markets. This particular class of bond is considered separately, because of their significant presence only in these two markets.

Figure 6 shows the evolution of wealth investing in Brazilian ILBs obtained by applying the Sharpe Ratio, and we can observe that this kind of investment is quite profitable during all the time considered.

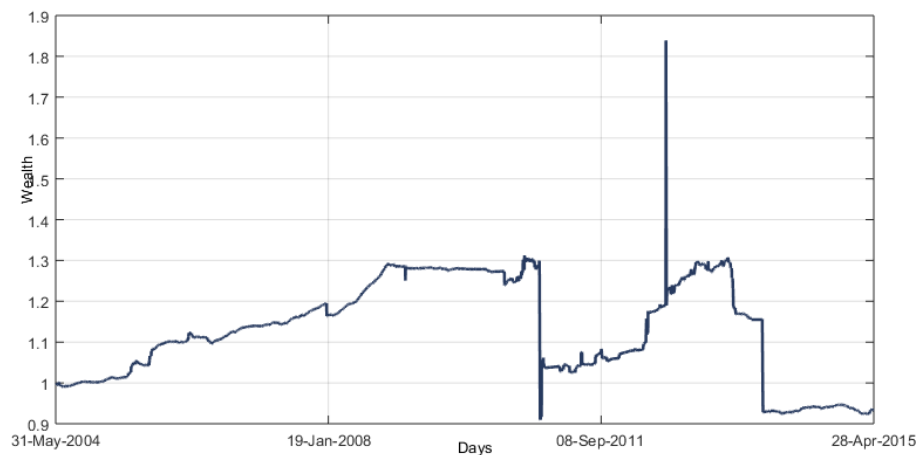
Figure 6: Ex post wealth on Brazilian Inflation Linked Bond market



Conversely, as showed in Figure 7, that outlines the evolution of wealth investing in ILBs of South Africa markets, the investment seem to be characterized by higher risk and uncertainty. Are also evident in the chart, two high spikes, upwards and downwards (in 2010 and 2012 respectively), that suggest an high volatility of this market.



Figure 7: Ex post wealth on South African Inflation Linked Bond



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