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Paper Title: Assessing the readiness of BRICS grouping for mutually beneficial financial integration

This paper assesses the extent of the transmission of equity market volatility shocks between BRICS (Brazil, Russia, India, China and South Africa) countries to infer the degree of risk sharing within the grouping. The paper makes use of the spillover index methodology suggested by Diebold and Yilmaz (2012) for this end. Nonetheless, the paper extends this methodology by making use of *ex ante* volatility measures that account for long memory in equity markets. The paper finds asymmetric influences between BRICS countries in relation to risk sharing. The finding of the paper implies the possibility of unequal benefit that could result from possible capital liberalisation between BRICS countries.

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INTRODUCTION

At the time when a number of agreements and treaties aiming at strengthening financial and economic cooperation between BRICS countries are concluded, it is evident that the ultimate aim of the BRICS grouping is to further their financial and economic integration with the possibility of scrapping any barrier to capital movement such as their respective exchange control regulations. Nonetheless, such a decision for capital market liberalization among BRICS member countries should be informed by economic factors rather than simply by political stance if it is deemed to be mutually beneficial among all the member countries. It is unfortunate that approach to financial integration or capital market liberalisation has often been driven as much by philosophy and political circumstances as by economic factors (Kose, et al., 2009). The benefit of capital market liberalisation may be unequally shared when such a decision is taken without consideration of economic and financial dynamics. Risk sharing has been evoked as the most important prerequisite for beneficial financial integration or capital market liberalisation. It is in that context that a number of authors indicate that capital market liberalisation leads to the increase in economic growth, and thus beneficial to member countries, through the lower cost of capital that derives from risk sharing ((Bekaert, Harvey, and Lundblad, 2005). Risk sharing between countries encourages cross holding of foreign assets which insure domestic residents against country-specific shocks to their income. This logically allows for greater diversification of income risk which, in turn, spurs economic growth through greater specialisation (Kose, et al.; Kalemli-Ozcan, 2003). This reality suggests that the increased probability of spillover from shocks between country members of a specific grouping not only indicates the increased degree of financial integration but also show the possibility of a beneficial cooperation. Thus, successful and beneficial capital market liberalization between BRICS countries should be condition by the presence of risk sharing or cross transmission of risk or market volatility.

This paper endeavours to assess the extent and magnitude of cross transmission of equity market volatility shocks among the BRICS to infer the possible benefit that can result from capital market liberalization. The results of this paper should inform policy makers of BRICS member countries of whether it is beneficial at this juncture of time to further liberalise their capital market by scrapping the existing exchange control regulation for a free flow of capital within the grouping.

Given that exchange control regulation is applied in order to insulate countries against massive capital outflow and possible currency crisis, especially during major global and internal financial crisis, it is important to ascertain that any reversal of the regulation albeit only among BRICS partners will not affect small countries such as South Africa. It is well documented that in the context of globalization, big economies are beneficiary of capital flow, at the detriment of small economies, especially during periods of financial crises. For example, Mendoza et. al. (2009) show that the United States (US) has increased its net holding of risky assets, characterized by equity portfolio and FDI, since the inception of globalization in the 1980s. This is mainly due to the fact that investors perceive the US as a safe haven for their assets and that there is massive capital flow from risky economies to safer economies such as the US during major financial crises. Moreover, Stiglitz (2003), referring to the darker side of globalization, indicates that much of the instability that occurred in East Asia in the mid-1990s was because the affected countries yielded to the pressure for capital market liberalization without properly shielding their economies. The author supports safeguard measures such as exchange control regulation to manage the risk of capital market liberalization characterized by massive capital flow from less-developed economies to industrial economies.

It is intuitive that the US will attract capital flow from less developed countries, especially during the crisis periods, simply because there is no reciprocity or cross transmission of risks between the US and less developed economies. Crisis in the US can contaminate less-developed economies and the contrary is probably not evident. In the absence of risk sharing or cross transmission of shocks among countries, the benefits of financial liberalisation are unequally shared among nations. Countries that are able to transmit risks to others without being themselves exposed by risks from those countries set to become the main beneficiary and recipients of portfolio and direct investment inflow at the cost of countries that are fragile and susceptible to contaminations from external risks.

The difference in the size of BRICS economies may raise a concern on their mutual influence in terms of cross transmission of volatility shocks. China is the biggest economy of the BRICS countries. China GDP in 2011 is by far the largest among the BRICS economies. South Africa is the smallest economy in the BRICS grouping with a population of 50 million, close to 27 times less than in China. The 2011 GPD of South Africa is close to 18 times less than that of China, 6 times less than Brazil and 4 times less than Russia and India (World Bank, 2012). Moreover, the market capitalisation of the biggest mainland China's stock exchange, Shanghai Stock Exchange, is five times the market capitalisation of the South African's stock exchange, the Johannesburg stock exchange in 2011 (IMF, 2012). This notable difference in the size of the two economies may indicate the possibility of an unequal benefit that may arise from further financial liberalisation in the absence of risk sharing.

In order to assess the extent and magnitude of risk sharing or cross transmission of volatility shocks between BRICS countries, this paper makes use of the spillover measure based on forecast error variance decompositions from vector autoregressions (VARs) as proposed by Diebold and Yilmaz (2009, 2012). Nonetheless, this paper extends this methodology by modelling ex ante volatility spillover of the BRICS countries whereby volatility series are computed based on fractionally integrated general autoregressive conditional heteroskedastic (FIGARCH) model to account for long memory in their respective equity market.

The empirical results of the cross transmission of volatility shocks show that risks are shared asymmetrically between BRICS countries and that South Africa, a smaller BRICS country, is more of a receiver than a transmitter of volatility shocks in the grouping.

The paper proceeds as follows. In section 2, the methodological approach is discussed with a particular focus on FIGARCH model as well as on volatility spillover approach used in the paper. Section 3 presents the results of the paper and the conclusion of the paper is provided in section 4.

METHODOLOGY

In order to assess the cross transmission of volatility shocks between BRICS economies, this paper employs the spillover index framework suggested by Diebold and Yilmaz (2009, 2012) and extends the framework to the case of *ex ante* volatility spillover with volatility series obtained from FIGARCH model. Diebold and Yilmaz's spillover index is based on the vector autoregressive model (VAR) model specified as :

$$Y_t = \beta Y_{t-1} + \varepsilon_t \qquad (1)$$

Where Y_t is the vector of equity return volatilities of BRICS countries as in this paper. Applying Wold decomposition in Equation 1, the following moving average of the VAR can be obtained:

$$Y_t = \Theta(L)\,\varepsilon_t \qquad (2)$$

Where $\Theta(L) = (1-\beta L)^{-1}$. The structural form of Equation 2 can be represented as $Y_t = A(L)\mu_t$

Where $A(L) = \Theta(L)Q_t^{-1}$ and $\mu_t = Q_t \varepsilon_t$. Q_t Can be identified by using the lower-triangular Choleski decomposition.

With a 1-step-ahead forecasting given by

$$Y_{t+1} = \beta Yt$$

and the error vector of the n variables in the vector Y_t represented by

$$e_{t+1,t} = Y_{t+1} - Y_{t+1,t} = A_0 \mu_{t+1} = \begin{bmatrix} a_{0,11} & a0{,}12 \ ...\ a0.1n \\ a_{0,21} & a0{,}22 \ .. \quad a0{,}2n \\ . & \\ . & \\ . & \\ a_{0,n1} & a0,n2 \ ....\ a0,nn \end{bmatrix} \begin{bmatrix} \mu 1, t+1 \\ \mu 2, t+1 \\ . \\ . \\ . \\ \mu n, t+1 \end{bmatrix}$$

and its covariance cab be expressed as

$$E(et+1, e'_{t+1,t} = A0A'_0$$

With this notation, the variance of the 1-step error in forecasting Y_{1t} is $a_{0,11}^2 + a_{0,12}^2 + \ldots + a_{0,1n}^2$. Diebold and Yilmaz made a difference between 'own variance shares' and 'cross variance share' where the former refers to the fraction of of the 1-step-ahead error variances in forecasting y_i due to shocks to y_i and the former the former, also known as 'spillover', refers to the fractions of the 1-step-ahead error variances in forecasting y_i due to shocks to y_j with $i \neq j$. Total spillover can be obtained by summing up all the cross variance shares. Therefore, the spillover index is obtained by the ratio of the total spillover and the total forecast error variation, also known as $trace(A_0 A_0)$. This spillover index is obtained by assuming orthogonalisation based on cholesky decomposition or factorization, which is order-dependent in a VAR framework. To obtain a spillover index that is independent of the results of ordering, Diebold and Yilmaz (2012) show that the genrealised VAR framework of Pesaran and Shin (19980 can be applied. Thus the volatility spillover index can be obtained as

$$S^g(H) = \frac{\sum_{i,j=1, i \neq j}^{N} \tilde{\theta}_{ij}^{g}(H)}{\sum_{i,j=1,}^{N} \tilde{\theta}_{ij}^{g}(H)} .100$$

Where $\tilde{\theta}_{ij}^{g}(H)$ is the normalised H-step-ahead generalised forecast error variance decomposition, which is independent of the order of variables in the VAR system (see Pesaran and potter, 1996; Pesaran and shin, 1998). $S^g(H)$ is the spillover index.

As the focus of this paper is on measuring the degree and magnitude of cross transmission of equity market volatility shocks among BRICs countries to infer the extent of their market risk sharing, the elements of vector Y_t, the volatility series, are obtained with the aid of FIGARCH model to account for long memory of equity market volatility and the persistence of their shocks. It is important to note that in the tradition of volatility modeling, IGARCH model has been often used to account for long memory of volatility series and the persistence of their shocks ( ). Nonetheless, Baillie et al. (1996) contend that the IGARCH model is too restrictive as it implies infinite persistence of volatility shocks. The authors introduce the FIGARCH model that account for the presence of long-memory, however, the model allows a slow hyperbolic rate of decay of volatility shocks.

It can be proven that the IGARCH model is a particular case of the FIGARCH model. Given for example an IGARCH (p,q) expressed as

$$ht = \alpha 0 + \sum_{i=1}^{q} \alpha i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta j ht - j$$

With $\sum_{i=1}^{q} \alpha i + \sum_{j=1}^{p} \beta j = 1$

Equation can be written as

$$ht = \alpha 0 + \alpha(L)\varepsilon_t^2 + \beta(L)ht$$

Where L is the lag operator and $\alpha(L) = \alpha 1L + \alpha 2L + \ldots + \alpha qL$

The IGARCH model can be expressed as an ARMA process in ε_t^2 as follows:

$$[1 - \alpha(L) - \beta(L)](1 - L)\varepsilon_t^2 = \alpha 0 + [1 - \beta(L)]vt$$

Where $\nu t = \varepsilon_t^2 - ht$ and it is interpreted as the shock to conditional variance.

Baillie et al. 9) show that the FIGARCH model is obtained by replacing the first difference operator $(1-L)$ in the above equation by $(1-L)^d$ with $0 < d < 1$.Thus, the ARMA representation of the FIGARCH model is written as

$$[1-\alpha(L)-\beta(L)](1-L)^d \varepsilon_t^2 = \alpha 0 + [1-\beta(L)]\nu t$$

It is clear from this representation that if d is close to unity, the FIGARCH model becomes closer to an IGARCH model, indicating long persistence of volatility shocks.

DATA AND EMPIRICAL ANALYSIS

The ex ante volatility series used to estimate the volatility spillover index between BRICS countries are modelled with the use of FIGARCH model. The series are obtained in two steps .First, BRICS equity market returns are computed as the first difference of the natural logarithm of MICEX index (Russia), Johannesburg All Share Index (South Africa), S&P CNX Nifty index (India), BOVESPA index (Brazil) and Shangai stock exchange index, A share and B share (China). Those equity market returns are expressed in percentage. Then, the AR(1)-FIGARCH(1,1) model is used to obtain the volatility series for each country based on misspecification tests of non-serial correlation and no remaining ARCH effect after estimation.

After estimating each equity market volatility from FIGARCH model, Table 1 reports the volatility spillover index between BRICS countries. There are a number of observations from Table 1 with regards to the spillover of volatility shocks among BRICS countries. The spillover index is decomposed into forecast error variance component for variable I coming from shocks to variable j, for all I and j. the total spillover index is reported in the lower right corner of Table 1. The results show that only 16% of equity market forecast error variance comes from spillover within BRICS grouping. There is also asymmetric effect of volatility shocks that emanate from different countries. For example, innovations to Brazil equity market volatility are responsible for 8.7% of the error variance in forecasting 10-week-ahead South African equity market volatility.

Table 1. Spillover table, BRICS stock market returns volatility

			RUS	ZAR	IND	BRA	CHI	From Others
RUS			86.2	10.1	1.1	1.9	0.8	14
ZAR			23.1	62	4.1	8.7	2.2	38
IND			2	1.4	92.7	1.4	2.6	7
BRA			13.6	4.8	1.3	77.4	2.9	23
CHI			1.1	0.1	0.2	0.4	98.2	2
Contribution to others			40	16	7	12	8	84
Contribution including			126	78	99	90	107	16.70%

This reality suggest that the different effects of volatility shocks on each other volatilities indicate that risks are not equally shared within BRICS grouping. This shows that some of the countries are dominant within the grouping. Thus, there is a risk that any full capiltal market liberalisation within BRICS can benefit dominant countries at the detriment of country such as South Africa which seems to be the receiver rather than transmitter of risks within BRICS.

CONCLUSION

This paper assesses the transmission of volatility shocks within BRICS countries by making use of the spillover index methodology suggested by Diebold and Yilmaz (2012). Nonetheless, the paper extends their methodology by making use of an ex ante volatility measure that account for long memory in the equity market to model equity market volatility series. The paper shows that there is asymmetric reaction to volatility shocks by the different members of the BRICS grouping.