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Assessing the extent of contagion of sovereign credit risk among BRICS countries

Abstract

This paper contributes to the literature of sovereign credit risk contagion by conducting a counterfactual analysis on credit risk spillovers among BRICS countries. The conditional value-at-risk (CoVaR) methodology is used to this end. Moreover, the paper makes use of the generalised forecast error decomposition to assess the contribution of state variables in the CoVaR of each of the BRICS countries conditioned by China, the biggest economies of the BRICS. The findings of this paper show that credit risk distress in China affects the most all countries sovereign credit risk in the BRICS grouping. Moreover, the channel through which credit risk distress in China affect other BRICS country is not homogenous.

1. Introduction

Literature on sovereign credit risk spillover has resurged since the advent of the European sovereign debt crisis. The European sovereign debt crisis started in 2008 with the main trigger being the collapse of Iceland's banking system. The crisis spilled over to Greece, Ireland and Portugal during 2009 and led to the collapse of their financial institution and the rapid increase in the yield spread of their government securities (Arghyrou and Kontonikas, 2012). The crisis culminated in 2009 when it was revealed that Greece underreported its budget deficit to escape the guidelines set by the Maastricht treaty. The crisis spread in many Eurozone states as most of these states found it difficult to finance their budget deficit due to the high interest rates lenders demanded on Eurozone sovereign debt instruments. Although the contagion effects of the European sovereign debt crisis were evident in Eurozone states and worldwide, not all the states were affected the same way (Mink and De Haan, 2013). This reality shows that the contagion effects of the sovereign credit crisis, or any crisis for this matter, is not symmetrically distributed.

A number of studies attempts to assess the extent of contagion of the European sovereign debt crisis in Eurozone and worldwide. For example, Galarioti et al. (2016) examine the drivers of credit default swap (CDs) spreads and potential spillover effects for Eurozone countries during the European debt crisis. The authors make use of a panel vector autoregressive (PVAR) model and find that the determinants of CDs variances neither are the same nor stable during different periods and in different Eurozone countries. For example, the authors find that the slope of the

term structure affects differently the CDs spread variances in peripheral Eurozone countries such as Greece, Italy, Spain compared to core Eurozone countries such as France, Germany, Netherland and Belgium. Burietz and Ureche-Rangau (2016) make use of the game theory approach to show that Greek sovereign debt crisis created significant spillover risk for the other Eurozone economies. However, Kalbaska and Gatkowski (2012), analysing the dynamics of credit default swaps of Greece, Spain and other countries, show that Greece has a lower ability to initiate the contagion effects of credit risk than core EU countries. Halaj, Peltonen and Scheicher (2016) make use of both network tools and panel data analysis and find little evidence of the direct impact of the Greek sovereign debt crisis other Eurozone countries. The authors show that credit risk related to the risk of Greek sovereign debt causes temporary spillover effects on CDS spreads of other Eurozone countries.

While literature on sovereign debt crisis contagion have focused mostly on developed economies, especially by considering developed economies as the source of contagion, very few studies focus on sovereign debt crisis contagion among emerging markets. For example, Kaminsky and Schmukler (2002) show that changes in sovereign debt rating in emerging economies directly impact on the markets of the countries rated in emerging economies and engender cross-country contagion. This contagion effect intensifies during periods of crisis. However, to the best of our knowledge, none of the studies has focused on assessing the effects of sovereign debt crisis or credit risk contagion among BRICS (Brazil, Russia, India, China and South Africa) countries. In addition, studies on sovereign credit risk contagion are often conducted *a posteriori*, i.e., contagion effects are assessed after the crisis has occurred (see Galarioti et al., 2016; Mink and De Haan, 2013; Kalbaska and Gatkowski , 2012). However, this paper contributes to the literature of the sovereign credit risk contagion by conducting a counterfactual analysis on the possible effects of credit risk spillovers among BRICS countries. The CoVaR methodology is used to this end. Moreover, the paper makes use of the generalised forecast error decomposition to assess the contribution of state variables in the CoVaR of each of the BRICS countries conditioned by China, the biggest economies of the BRICS. The findings of this paper will allow assessing how much a distressed country within the BRICS grouping adds to the risk of peer countries in the grouping.

Studying the sovereign credit risk contagion between BRICS countries is important given the magnitude of interaction between member countries and what the BRICS countries represent globally. The BRICS countries represent the world's leading emerging market economies (EME), distinguished by their large, fast-growing economies. The growth potential of BRICS countries is informed by their diverse attributes. On one side, BRICS grouping includes resource-rich countries such as Brazil, South Africa and Russia. On the other side, BRICS comprises countries with huge

manufacturing base and highly skilled workforce such as China and India. This diversity augur well for profitable exchanges among BRICS member states. Moreover, BRICS financial indicators are comparable to those of developed economies and the size of its stock exchange more than doubled between 1999 and 2009, and BRICS market capitalisation in stock markets grew from US\$1.2 trillion to US\$6.4 trillion between 2000 and 2010 (New Delhi, 2012). The growing influence of BRICS financial markets offer an opportunity for asset managers to diversify their portfolio efficiently. However, this can occur only if asset managers and policy makers are well informed about the extent of cross-transmission of shocks in general and sovereign credit risk contagion in particular between BRICS countries.

It is important to note that a number of factors contribute to credit risks in emerging market in general and BRICS in particular. Some of these factors include currency appreciation, risk premiums, liquidity squeeze and yield spread. Corte, Sarno, Scheniling and Wagner (2015) show most of the changes in sovereign credit risk, be it in developed and emerging markets, are attributed to the change in the value of their currencies. These findings are also supported by Alexopoulou et al. (2009) who apply an error correction model and find that exchange rate along with yield spread play a fundamental role in determining the cost of borrowing for the sovereign hence impacting on credit riskiness of the country. A study conducted by Saadaoui and Boujelbene (2007) finds that liquidity squeeze is a significant variable in determining credit risk of emerging markets. They further assert that liquidity is one of the most crucial factors in the gradual improvement of sovereign bond markets in emerging markets. Özatay et al. (2009) suggest that credit ratings play a fundamental role in influencing sovereign credit risk of emerging markets. Gonzalez-Rozada and Yeyati (2008) support these results with their own study, which finds that a negative rating from rating agency S&P significantly increases the sovereign credit risk of more than 30 developing and emerging markets. Credit rating agencies such as Fitch, S&P and Moody's offer ratings that evaluate a country's ability to meet its debt obligations by mainly focusing on socio and macroeconomic indicators. South Africa has recently been downgraded by two of the three largest rating agencies because of poor short term to medium term growth prospects and an increasing government debt. The downgrade implies a reduction in the creditworthiness of South Africa and an increase in the nation's credit risk. In September 2017, China the biggest BRICS economy also got a downgrade on its sovereign debt because of a continued increase in the country's debt. However, unlike South Africa, China's economic outlook is forecasted to be stable even though they have been downgraded. While these credit ratings might not be taken seriously in China, which rarely depends on external funding, for South Africa whose access to sources of funding is uncertain hence these ratings should play a significant role. Unfortunately, there is no

literature that has ever assessed the contagion effects of sovereign credit risk among BRICS economies.

CoVaR^{*i/j*} denotes the value at risk (VaR) of an institution *j*, or a set of institutions, conditional on some events occurring to institution *i* (Andrian and Brunnemeier, 2016). In the context of this paper the CoVaR methodology will provide insights on how the value at risk of a specific BRICS country, or a set of countries, will be affected conditional on the rising of sovereign credit risk in another BRICS country. The CoVaR methodology as applied in this paper will not only contribute to assess the extent of sovereign credit risk transmission or contagion but will also provide a counterfactual analysis for an *ex ante* policy evaluation. The remainder of the paper is divided as follows; section 2 presents the methodology used in the paper, section 3 discusses the data used, estimate the model and discusses the results, Section 4 concludes the paper.

2. Methodology

This section presents the methodology used in this study. It shows how the CoVaR is modelled, mainly by making use of the quantile regression when estimating the value-at-risk related to sovereign credit risk.

2.1. CoVaR Definition

Given Y_t , the returns of a bond for example, we can statistically define the VaR of a bond as the q quantile of the distribution of its returns over the confidence level $1-q$. This can be represented as follows

$$\Pr(Y_t^i \leq VaR_{t,q}^i) = q \quad (1)$$

Where Y_t^i represents the returns of a bond in country *i* and $VaR_{t,q}^i$ is the q percent value at risk for country *i*.

Adrian and Brunnermeier (2009) define CoVaR as the Value-at-Risk of the system given that one institution is already at its VaR. In the context of this study, CoVaR would mean the extent of the exposure to credit risk by some of the BRICS countries when one of the BRICS country is in distress (exposed to credit risk). Hence, the concept of CoVaR is statistically defined as the q th quantile of a country's returns' distribution on condition that the returns of another individual country are equal to the VaR. This can be represented as follows:

$$\Pr(Y_t^j \leq CoVaR_{t,q}^{j|i} | Y_t^i = VaR_{t,q}^i) = q \quad (2)$$

Where Y_t^j are the returns of the country j at time t and Y_t^i are the returns of country i at time t .

2.2. Estimation Procedure

CoVaR makes use of value-at-risk (VaR) as the basic measure for risk. It is often used to assess the extent of risk contagion between countries or institutions. Given that VaR is often obtained by making use of the quantile regression (see Gaglianone, et al., 2011 ; Taylor, 2008) , it is understandable that the first step in estimating CoVaR requires the use of quantile regression to determine the lowest quantile, which represents situations of distress. Thus, in the case of this paper, we estimate sovereign credit risk for each of the BRICS country, proxied by the change in the sovereign yields, at $q= 5\%$ quantile making use of the following equation:

$$Y_{t,q}^i = \beta_{0,q}^i + \beta_{1,q}^i M_t + \varepsilon_t^i \quad (3)$$

Where M_t represents the set of states variables or possible determinants of sovereign credit risk.

In the second step, we calculate the VaR of the individual countries from the predicted values of Equation 3.

After estimating the VaR of country i we then estimate the CoVaR of country j . the CoVaR of country j is obtained by controlling each of the VaR of country j with different state variables and the VaR of country i . The expression is represented as:

$$CoVaR_{t,q}^{j|i} = \widehat{\beta}_{0,q}^j + \widehat{\beta}_{1,q}^j VaR_{t,q}^i + \widehat{\beta}_{2,q}^j M_t \quad (4)$$

Where $VaR_{t,q}^i$ is the value-at-risk of country i .

It is worth noting that Equation 4 makes use of the predicted values or out-of-sample estimation of the estimated CoVaR of country j .

Given that the aim of this paper is to assess the extent of contagion of sovereign credit risk among BRICS countries, this is achieved by estimating Delta CoVaR ($\Delta CoVaR$), which is the difference between the CoVaR of country j when country i is in distress and the CoVaR of country j when country i is in normal state. $\Delta CoVaR$ provides a tool to assess how a risk of an institution or country changes when a particular institution or country becomes financially stressed. It is then used to measure the extent of risk contagion between countries or institutions. $\Delta CoVaR$ is represented as follows:

$$\Delta CoVaR_{t,q}^{s|i} = CoVaR_{t,q}^{s|i=VaR} - CoVaR_{t,q}^{s|i=normal} \quad (5)$$

3. Data, Estimation and Results

3.1. Data

In analysing the extent of contagion of sovereign credit risk between BRICS countries, this paper considers daily benchmark yields for ten-year government bonds for Brazil, Russia, India, China and South Africa with the sample spanning from March 2008 to May 2017. The sample includes periods of major financial crises such as the global financial crisis and European debt crisis, thus, providing a valuable opportunity to assess sovereign risk contagion among BRICS countries during tumultuous periods.

Typically, credit default swaps (CDS) spreads data are often used in the literature to measure credit risk. Because of data unavailability for some of the BRICS countries we opted to use bonds yields, which may also be used to proxy credit risk and , have been proven to produce the same results as the CDs spreads (see Lange, Lucas and Siegmann, 2016)..

In implementing quantile regression for VaR and CoVaR estimation¹, we follow Afonso et al., (2012)and Wong and Fong (2011) by making use of a set of important variables that influence sovereign bond yields, namely the business cycle (YSPRE), liquidity squeeze (LIQS), global risk premium (RISKP)and currency fluctuation (CURR). . The business cycle is proxied by the yield spread between each country's 10-year government bond and the three -month Treasury bill. Liquidity squeeze is calculated by taking the difference between the repo rate and 3-month Treasury bill. The difference between the MSCI world index return and 3 month US Treasury bill proxies the global risk premium and the change in the exchange rate between the countries in question's currency and the US dollar represents the currency appreciation/depreciation.

Figure 1 presents the display of the bond yields for the five BRICS countries. The figure shows that during the sample period considered by the paper, the yields of China did not change much and were constantly the lowest in the BRICS block. Brazil records the highest yield on average among BRICS countries. It is important to note the highest yield of Brazil's government bond should be attributed to the high level of its government debt GDP reaching 74.04% in 2017.² Another salient feature of Figure 1 is that the bond yields of all the BRICS countries increased during the 2008 global financial crisis except those of China that have remained relatively flat during the period 2008-2017. The noticeable increase in government bond yield for Russia in 2014

¹ See Equations 3 and 4.

² Statistics provided by Trading Economics, available at <http://tradingeconomics.com>

reflects the consequences of international sanctions imposed on Russia following its military intervention in Ukraine with the yield in government bond reaching 16.05% in January 2015 from a low of 8.46% in June 2014. Moreover, Figure 1 shows a spike in government bond yield in 2015 in Brazil. This is due to the economic crisis in the country due to political paralysis that culminated to the impeachment of President Rousseff. The economic crisis affected investors' confidence and led to the increase in the yield in government bond reaching 16.85% in September 2015.

Figure 1: Bond Yields

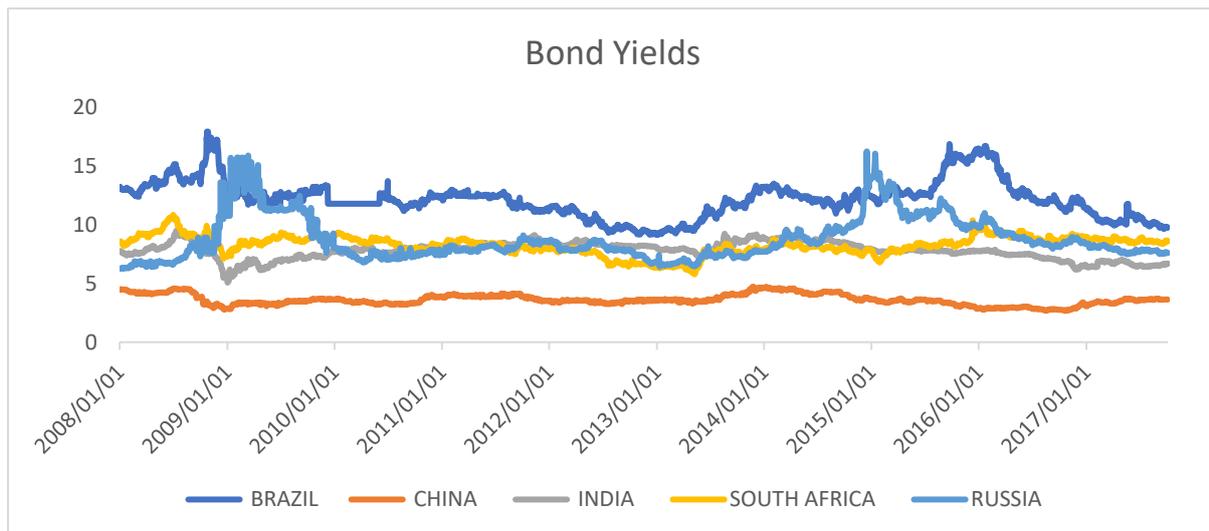


Table 1 presents the summary statistics for the change in bond yields. It is worth noting that the change in bond yield should approximate the returns of government bonds given the negative relationship between bond yields and bond prices. The results reported in Table 1 show that the means of the yield changes of government bonds is negative for all the BRICS countries. Given the negative relationship between bond yields and bond prices, the negative sign reflects the increase in bond prices and positive returns for all the BRICS countries bonds during the period 2008 – 2017. Russia and Brazil have the highest standard deviation of government bond yields. This is confirmed with the display in Figure 1 showing higher volatility of the yields of the two countries.

Table 1: Summary Statistics for Bond Yield Changes

	Brazil	China	India	RSA	Russia
Mean	-0,0058	-0,0026	-0,0046	-0,0013	-0,0012
St. dv	0,5974	0,5537	0,3677	0,4164	1,2607
Kurtosis	15,9417	7,4359	29,0783	13,4258	34,403
Skewness	0,3571	-0,4185	1,1388	1,2818	1,6048
Minimum	-5,3070	-3,3334	-2,5858	-2,4230	-10,073
Maximum	6,8430	3,1671	5,3145	4,9209	16,452

3.2. CoVaR estimation and Results

Using quantile regression, we estimated the CoVaR at the 95 percent confidence level for each BRICS country's sovereign debt market by making use of Equation 4. Table 3 reports the results of the delta CoVaR, as in Equation 5, for all BRICS countries. As stated earlier, Delta CoVaR measures how much a distressed country adds to the risk of a peer country when it moves from operating normally to being in a state of distress. In Table 3, column 1 indicates how much Brazil adds to the credit risk of the other four countries. For example, the results reported in Table 1 show that when Brazil enters a state of distress it increases the risk in Russia by 16.4 percent (0.164), whilst it adds 7, 8 and 13 percent to China, India and South Africa respectively. The findings mean that the Brazil will be the most affected whereas China will be least affected when Russia's sovereign debt markets malfunction. A look at column 2 shows that the results are not symmetric as a distressed Russia only adds 1.4 percent to the credit risk Brazil, making Brazil the least vulnerable country to a distressed Russia. South Africa, the smallest economy in the BRICS grouping, is on average the most affected countries by credit risk contagion from other BRICS countries. For example, the results of the net mutual contagion show that Brazil increases the credit risk contagion to South Africa by close to 14%, while credit risk in Brazil augments by 4.4% when South Africa is in distress. Distress in China affects the most all countries in the BRICS grouping. For example, distress in China increases sovereign credit risk in India by close to 23.5% while distress in India changes credit risk in China by 19%. The finding that China is the most influential countries in the BRICS grouping in term of sovereign credit risk contagion is supported by many studies. For example, Bonga-Bonga (2017) finds that there is an asymmetric influence

among BRICS countries with in term of the cross transmission of shocks with China being the most influential BRIKCS country.

Table 3: Delta CoVaR

	Brazil	Russia	India	China	South Africa
Brazil		0,014076	0,02044	0,188607	0,044437
Russia	0,164796		0,141655	0,179624	0,048243
India	0,086232	0,047863		0,235327	0,107268
China	0,078128	0,079715	0,178661		0,04868
South Africa	0,139177	0,227491	0,189192	0,124221	
Average	0,117083	0,092286	0,132487	0,181945	0,062157

In table 3, the last row shows how much on average the risk of the other economies increases when one economy is in distress. On average China will increase the risk of other BRICS countries by 18 percent when in distress. This figure also proves to be the largest among the averages, meaning that China has the largest significant effect on the other economies.

3.3. Variance Decomposition

The results reported in Table 3 show that China has the largest potential to transmit sovereign credit risk to other BRICS countries. However, it is important to assess the extent to which each variables³ contribute to this contagion. It is in that context that this sub-section intends to analyse the impact of the innovation to each variables on the credit risk transmitted by China to other BRICS countries. The paper makes use of the generalised forecast error variance decomposition to this end (see Pesaran and Shin, 1998).

Figure 2 shows that in the short-term 18 percent of the variance of conditional credit risk transmitted by China to South Africa are attributed to shocks to liquidity squeeze whereas shock to risk premium accounts for around 11 percent in explaining the variation of the conditional risk transmitted by China. This finding implies that liquidity squeeze accounts for the most part in the

³ We focus on the states variables that determine the COVAR as in Equation 4, namely, liquidity squeeze, risk premium, credit rating and currency fluctuation

fluctuation of the conditional credit risk contagion in South Africa. Over the long horizon liquidity squeeze continues to dominate as an important contributor to the conditional credit risk transmitted from China to South Africa. This finding shows that when China's sovereign credit market is in turmoil, there is a likelihood that other emerging market such as South Africa will be impacted negatively through sharp sell-off in their equity and bond markets. The dollar liquidity squeeze that ensues is often due to massive foreign capital outflow from these markets.

Figure 2. Variance Decomposition of conditional credit risk transmitted from China to South Africa

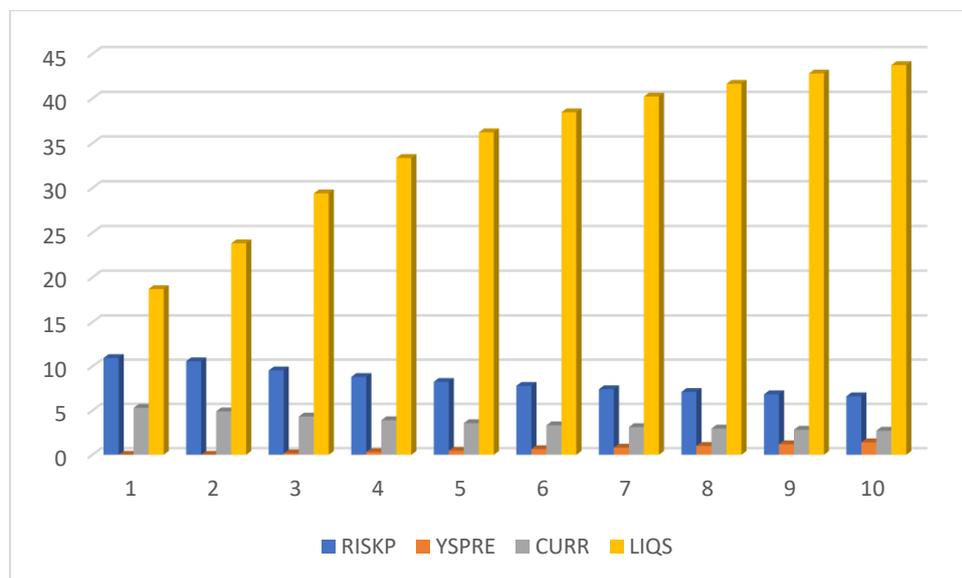


Figure 3 shows that innovation to global risk premium contributes the most to the variation of credit risk transmitted by China to Brazil. Although the global risk premium continues to dominate as the largest contributor to shocks to credit, risk contagion from China, however, the contribution of the business cycle increases over time. The rationale behind this finding is that sovereign credit risk crisis in China should fuel global risk premium and given the susceptibility of Brazil to global risk premium (Dungey, et al., 2006), it is evident that innovation to global risk premium should become an important channel through which sovereign credit crisis in China is transmitted to Brazil.

Figure 2. Variance Decomposition of conditional credit risk transmitted from China to Brazil

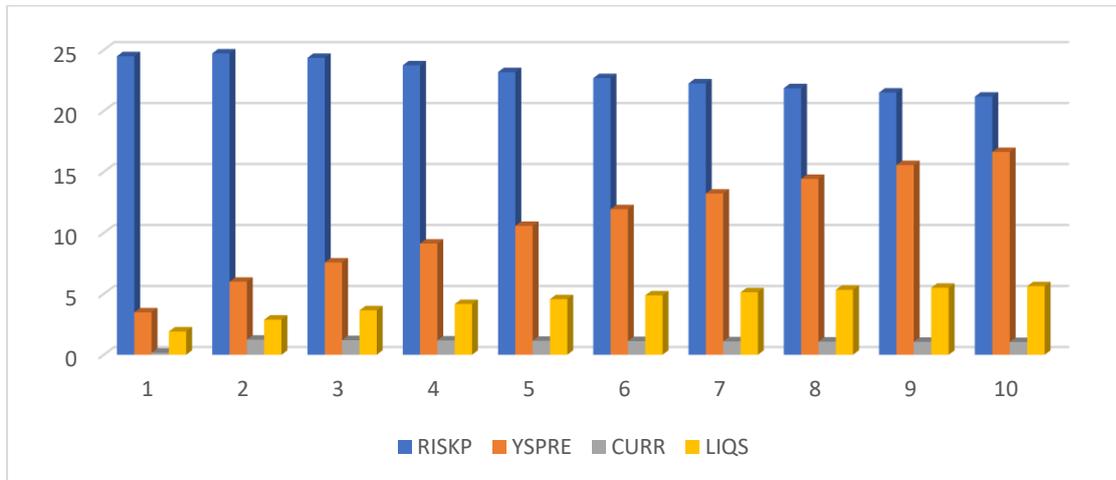


Figure 4 shows that innovation to liquidity squeeze and business cycle contribute the most to the variation of credit risk transmitted by china to Russia. A number of studies find that China’s business cycle converges with that of a number of emerging markets, especially Russia, due to their increase in trade (See Calderon, 2008 and Cesa-Bianchi, 2012). It is evident that the occurrence of credit crisis in China will affect the country’s business cycle. Thus, the business cycle should become an important channel through which credit risk in China is transmitted to Russia.

Figure 4. Variance Decomposition of conditional credit risk transmitted from China to Russia

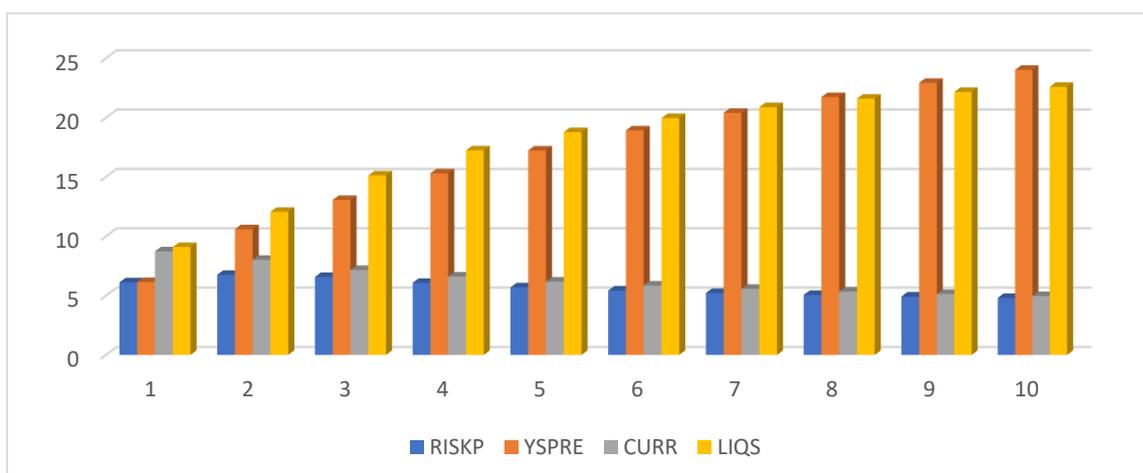
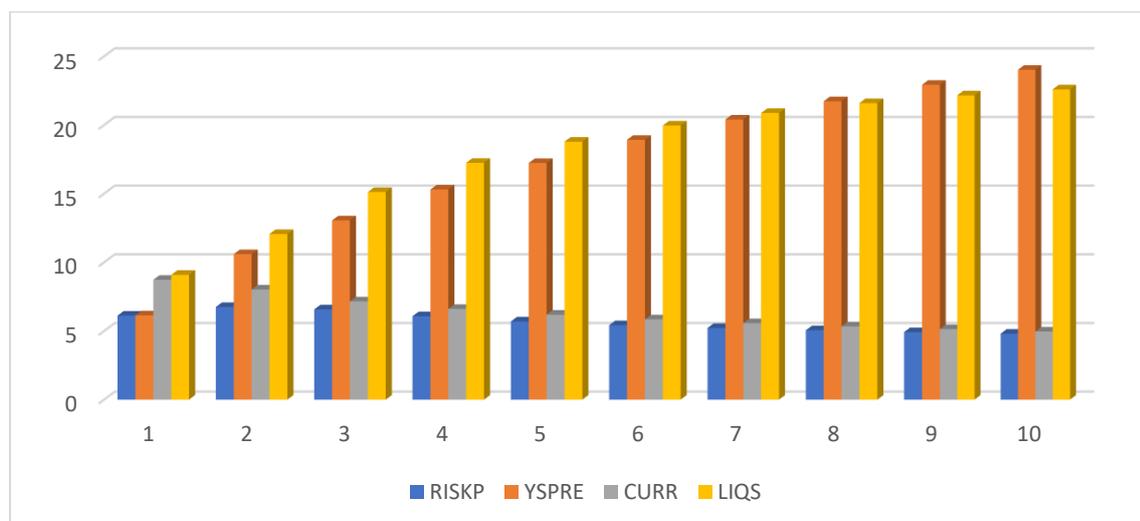


Figure 5 show that like in the case of Russia, innovation to liquidity squeeze and business cycle contribute the most to the variation of credit risk transmitted by china to India. This shows that the comovement of the business cycle between China and India is an important source of shock transmission. Moreover, like in the case of South Africa where liquidity squeeze is an important channel of shock transmission to credit risk, it is important to infer that when China’s sovereign credit market is in turmoil, there is a likelihood that India will be impacted negatively through sharp sell-off in their equity and bond markets.

Figure 5. Variance Decomposition of conditional credit risk transmitted from China to India



4. Conclusion

This paper assessed the extent of sovereign credit risk spillover among BRICS countries. In fact, the paper examined how a sovereign credit risk that emanates in one of the BRICS countries transmit to other BRICS countries. The paper makes use of the CoVaR methodology to this end. The results of the empirical analysis show that China has the largest potential to affect the sovereign credit risk of other BRICS countries. . For example, credit risk distress in China increases sovereign credit risk in India by close to 23.5% while distress in India changes credit risk in China

only by 19%. Moreover, the paper analyses the impact of the innovation to each variables on the credit risk transmitted by China to other BRICS countries. The results show that the extent of the contribution of the main variables to sovereign credit risk transmitted by China varies according to specific BRICS countries. For example, the results that innovation to liquidity squeeze and business cycle contribute the most to the variation of credit risk transmitted by china to Russia. While innovation to global risk premium contributes the most to the variation of credit risk transmitted by China to Brazil.

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