Risk ratings and stock prices: the causal nexus in BRICS countries

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Abstract: This paper investigates the nature of causal relations between risk (economic risk, financial risk and political risk) and stock prices in five BRICS countries (Brazil, Russia, India, China and South Africa), applying the Granger causality test over a period of 20 years from 1992 to 2012. The study bridges a gap in the literature, as prior macroeconomic empirical investigation has been limited to a possible link between risk ratings and stock prices. Our modelling includes BRICS stock price indices and three risk ratings, namely economic risk ratings, financial risk ratings, and political risk ratings. To achieve our objective, two econometric methodologies were adopted: cross-country regressions and time series regressions. The empirical results of this study indicate that for Russia and China (and the BRICS counties as a group), there is a unidirectional causality between political risk and economic risk. Another noteworthy result was the fact that a unidirectional causality between economic risk and share prices were found for India and China (and the BRICS countries as a group), but not for the other countries under review. This indicates the important role that the stock market plays in the economies of India and China and hence provides an extra caution for prospective investors in these countries.

Keywords: risk; stock prices; Brazil, Russia, India, China and South Africa; BRICS.

Reference to this paper should be made as follows: Pradhan, R.P., Hall, J.H., de São Pedro Filho, F. and Joseph, T. (2014) 'Risk ratings and stock prices: the causal nexus in BRICS countries', *Int. J. Banking, Accounting and Finance*, Vol. 5, No. 4, pp.435–459.

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The paper is a revised and expanded version of a paper entitled 'Risk assessment and stock prices in BRICS: the panel VAR modeling' accepted at the 2013 IEEE International Conference on Industrial Engineering and Engineering Management, Bangkok, 10–13 December 2013.

1 Introduction

The recent global financial crisis that emanated from the USA adversely affected stock prices in both developed and developing countries and continues to reverberate throughout the world economy. Stock is a common and important commodity in the capital market, and high stock prices have a positive effect on economic growth (Enisan and Olufisayo, 2009). However, stock markets are very sensitive to both the internal and external business environments in a country or region. According to Rafaqet and Muhammad (2012), stock prices tend to be volatile and generally respond rapidly to political, economic, financial, regional, national and foreign decisions and changes. Moreover, country-specific economic, financial and political factors have a specific effect on the stock markets of the country concerned, posing a particular risk. The relevance of these two variables (risk and stock prices) was already identified in Markowitz's portfolio theory in the mid-twentieth century. The theory of stock price behaviour originates from Markowitz (1959), whose model postulates that all rational investors want to maximise a portfolio's expected return, subject to an acceptable level of risk.

Risk refers to the expectation that the actual return on assets will be lower than the expected return. This simply implies that there is a probability that a stock investor will potentially lose on an investment as a result of changes in stock prices. In a broader sense, risk consists out of three main components and can thus be evaluated from a financial risk, economic risk and political risk perspective. Financial risk is the risk associated with financing a stock and can also arise from the possibility of a government's defaulting on its bonds. Financial risk arises from the nature of a business's capital structure. It is the probability of loss inherent in financing methods which may impair the ability of a business to provide adequate returns in which changes in the stock price are included. Financial risk can be systematic (interest risk, inflation risk and liquidity risk or non-systematic (management and credit risks). Generally, financial risk includes market risk, credit risk, liquidity risk and operational risk. Political risk arises from changes in a government, its legislative arms, among foreign policy-makers, military control, etc. More broadly speaking, political risk relating to stock prices refers to the complications investors could face as a result of a political situation or political decisions. According to Ephraim (1997), one can distinguish between macro- and micro-political risk, and their effects on stock prices differ. Changes in the political arena can influence the behaviour of stock returns, especially the price of stock. The impact of political risk could reduce an investment's stock return and even make stock less liquid.

Economic risk can be defined as the likelihood that stock prices will be influenced by macroeconomic fundamentals, such as monetary and fiscal policies, by affecting variables such as the exchange rate, inflation or the interest rate. The international literature contains a large number of studies (such as Vithessonthi, 2014; Clark and Kassimatis, 2004; Esqueda et al., 2002) using different statistical approaches to identify the relationship between risks and stock markets. The results of these studies are inconclusive and seem to be determined by the characteristics of the dataset (such as the time period or originating country) and the statistical measure used. The present study wants to make a contribution to the body of knowledge by firstly using two different econometric methodologies, namely cross-country regressions and time series regressions. Secondly, by using a dataset of the BRICS countries (Brazil, Russia, India, China and South Africa), this study will generate unique results on the relationship between the stock prices and risk of these countries which has not been conducted previously.

The results from this study will have a number of applications. Firstly, both international and local investors in the stock markets of these countries will be made aware of the political, economic and financial risk influences on the stock markets of these countries and how their stock returns could be influenced. Secondly, the economic and government policy makers within these countries will have an indication of the effects what their respective policies have on the stock market of their countries, as well as the comparative influences of their fellow countries in the BRICS alliance. By utilising this information, policy decisions could be aligned. Lastly, academic scholars will found value in the results of this study, as it has been conducted on a previously unutilised dataset coupled, with a powerful statistical technique and analysis.

The empirical results of this study indicate that for Russia and China (and the BRICS counties as a group), there is a unidirectional causality between political risk and economic risk. These two countries are the only two countries under review that do not have a well-established pure democratic political dispensation, which might explain this unidirectional causality. Another noteworthy result was the fact that a unidirectional causality between economic risk and share prices were found for India and China (and the BRICS countries as a group), but not for the other countries under review. This indicates the important role that the stock market plays in the economies of these two countries and hence provides an extra caution for prospective investors.

The remainder of the paper is set out as follows: the next section provides information on the data and the methodological framework used in the study; this is followed by a detailed discussion of the econometric results; the final section explores some policy implications of the findings and suggestions for further research.

2 Literature review

Erb et al. (1996) proposed a political risk score based on subjective analysis of available information, economic risk assessment based on an objective analysis of quantitative data, and financial risk measurement based on quantitative and qualitative data. In their research, they adopted different factors to assess each risk – financial risk, political risk and economic risks were proxied by five, 13 and six factors respectively. The calculation of the three individual indices is simply summed to get the points score for each factor in each risk category. The composite rating is a linear combination of the three individual point scores. The political risk measure (100 points) is given twice the weight of financial risk and economic risk (50 points each). Political risk was associated with willingness to pay a price, while financial risk and economic risk were associated with the ability to pay that price. The paper conducted research in both developed and emerging economies, and argued that both economic and financial risks have a considerable influence on stock value, while political risk has less effect. Erb et al. (1996) conclude that the levels of both economic risk and financial risk can predict the cross-section of expected stock prices.

Regarding political risk and its effects on stock prices, Diamonte et al. (1996) found that the effects of political events on emerging markets are stronger than the effects of such events on developed markets. This finding was confirmed by Aggarwal et al. (1999), who showed that in emerging markets (their study focused on Latin America and Asia), most fluctuations in stock markets are caused by national or regional political events. In a study on the Hong Kong Hang Seng stock index, Kim and Mei (2001) found that factors such as a negative political event, for example, the changing political status of Hong Kong upon its return to China, as well as human rights issues, have a significant effect on the stock index. Wang et al. (2011) also demonstrated that in Taiwan, political conflict resulted in political instability, and created uncertainty and fluctuations on the stock market. Political instability appears to have an adverse effect on stock markets, as reflected in a reduction in investment along with an increase in policy uncertainty (Erb et al., 1996; Diamonte et al., 1996).

The causal relation between exchange rates and stock prices is almost axiomatic: tradition holds that a change in exchange rates changes the profits of multinational corporations (especially the commodity-producing mining companies in the BRICS countries, which are the focus of the current study). Fang and Loo (1994) and Wu (2000) found that the extent to which stock markets are affected by exchange rate risk depends on the internationalisation of the economy of that country. A second approach to the effect of exchange rates on the stock market is based on the role that domestic interest rates play – an increasing domestic interest rate will have a positive effect on the exchange rate, but will have a negative effect on domestic stock prices (higher costs and discount rates).

Solnik (1987) investigated the relationship between exchange rates (economic risk) and stock prices in nine industrialised countries, and posited that the behaviour of the exchange rate could not explain changes in stock prices adequately. Muhammad and Rasheed (2003) also considered the effect of the exchange rate and stock prices in both India and Pakistan between 1994 and 2000, but could not find evidence of a relationship between the exchange rate (economic risk) and stock prices in either the short run or the long run (Stavarek, 2005). By contrast, Adler and Simon (1986) found that such a relationship existed, but reported only a weak correlation between stock prices and changes in exchange rates.

Liu (2010) examined asymmetric adjustments of the stock markets in the BRICS countries to changes or shocks in economic, financial and political risk ratings in the long and short run, using the momentum threshold auto-regression (MTAR) and the vector error-corrective (VEC) models (in contrast to the current study, which uses the Granger causality test). Liu's (2010) findings suggest that the long-run relationships between these four variables respond asymmetrically, depending on the directions of the shocks. In respect of the three-country risk ratings, the financial risk ratings displayed the most responsiveness to all the variables in the long run, whilst the political risk ratings were the least responsive. It was found that of the five BRICS countries' stock markets, the Chinese stock market seemed to adjust fastest in the short and long run. The economic and political risk ratings seemed to have the biggest influence on the Brazilian stock market, whilst the financial risk rating was the most prominent for the Russian stock market.

From the discussion above, it is clear that the empirical literature on the relationship between risk and stock prices is limited and inconclusive. The divergence in the views of previous authors leaves a gap in the academic literature which this paper intends to bridge. In line with the empirical literature reviewed in this paper, we adopted two different econometric methodologies: cross-country regressions and time series regressions. Cross-country regressions involve averaging out variables over long periods and using them in cross-section regressions aimed at explaining cross-country variations in risk ratings (Erb et al., 1996). Time series regressions ease the limitations associated with cross-country regressions and can detect the feedback relationships between the variables. We deployed time series regression to gather new evidence on the causal relationship between risk ratings and stock prices.

In the next section, the research methodology will be set out.

3 Data and methodological framework used in the study

This study addresses the relationships between financial, economic and political risk on the stock markets of the BRICS countries. The member countries of BRICS are developing or newly industrialised countries. According to the International Monetary Fund (2013), the five BRICS countries represent almost 3 billion people, with a combined nominal GDP of US$14.8 trillion, and they hold an estimated US$4 trillion in combined foreign reserves. Amidst the recent political, economic and financial turbulence across the world, the five BRICS countries appear to be pillars of stability and economic prosperity (Cheng et al., 2007). These countries are different from one another in respect of their history, culture, language, and economic structure (Biggemann and Fam, 2011). It has been said that their strengths outweigh their weaknesses, taking reasonable risk in the development process (Hammoudeh et al., 2013; Xu and Hamori, 2012).

The monthly time series data from 1992 to 2012 for five BRICS countries was employed to examine the causal relationship between various risk ratings and stock prices. The data were obtained from the International Country Risk Guide (ICRG) and DataStream. Our sample therefore consisted of an interesting group of emerging economies that have experienced tremendous economic growth and stock market development over the last two decades. We used BRICS stock price indices (SP) and three risk ratings: economic risk ratings (ER), financial risk ratings (FR), and political risk ratings (PR).

The ICRG of political risk services offers a composite index of country risk ratings, based on 22 macro-economic indicators and grouped under three broad heads, namely ER, FR and PR. They are used in this study in the form of composite scores ranging from 10 to 100 points (Hammoudeh et al., 2013; Brooks et al., 2004; Erb et al, 1996).

- ER is the composite score of five economic indicators, namely the per capita gross domestic product (GDP), the real GDP growth rate, the annual inflation rate, the budget deficit as a percentage of GDP, and the current account balance of payments as a percentage of GDP.
- FR is the composite score of four indicators, namely the foreign debt service as a percentage of GDP, the current account as a percentage of exports of goods and services, the months of imports cover, and exchange rate stability.
- PR is the composite score of 12 indicators ranging from government stability to conflict, corruption, democracy and bureaucracy.

The variables incorporated in the estimation process were used in natural logarithms so that their first differences approached the growth rates. The descriptive statistics of the data used in this study are summarised in Table 1, and the correlations between the variables are set out in Table 2.

The study tested the following hypotheses:

- H_1: The risk ratings in any time period Granger-causes stock price in a subsequent time period. This is termed the risk ratings-led stock price hypothesis.
- H_2: Stock price in any time period Granger-causes risk ratings in a subsequent year. This is termed the stock price-led risk ratings hypothesis.

Table 1 Summary statistics for the variables

Country	*Variables*	*Mean*	*Med*	*Max*	*Min*	*Std*	*Skew*	*Kur*	*JB*
Model 1: Individual country case									
Brazil	SP	3.93	3.88	4.64	3.11	0.38	0.27	2.28	7.84
	ER	1.52	1.53	1.61	1.38	0.05	–0.78	2.99	23.6
	FR	1.53	1.53	1.66	1.37	0.06	–0.60	3.21	13.9
	PR	1.82	1.82	1.85	1.78	0.02	–0.12	2.27	5.67
Russian Federation	SP	2.67	2.71	3.39	1.66	0.46	–0.21	1.96	9.73
	ER	1.55	1.58	1.66	1.20	0.10	–1.33	4.21	66.6
	FR	1.59	1.61	1.68	1.34	0.08	–1.01	3.05	31.7
	PR	1.79	1.81	1.84	1.62	0.04	–1.66	5.68	142
India	SP	1.82	1.71	2.45	1.44	0.28	0.71	2.16	26.5
	ER	1.53	1.54	1.57	1.41	0.03	–1.54	5.58	156
	FR	1.60	1.60	1.65	1.46	0.04	–0.63	3.01	15.3
	PR	1.78	1.79	1.84	1.63	0.04	–1.38	4.87	107
China	SP	2.29	2.28	2.91	1.58	0.26	0.11	2.78	0.91
	ER	1.59	1.60	1.62	1.46	0.03	–1.94	6.59	269
	FR	1.64	1.65	1.69	1.43	0.05	–1.67	6.56	230
	PR	1.83	1.83	1.88	1.77	0.02	–0.44	3.08	7.60
South Africa	SP	3.25	3.22	3.70	2.84	0.23	0.38	1.70	17.8
	ER	1.55	1.56	1.59	1.62	1.50	0.03	–0.76	3.11
	FR	1.58	1.59	1.62	1.50	0.03	–0.76	3.10	18.6
	PR	1.84	1.84	1.89	1.79	0.02	0.24	2.59	3.11
Model 2: Panel case									
BRICS	SP	2.78	2.68	4.64	1.44	0.83	0.31	2.11	52.4
	ER	1.55	1.56	1.66	1.20	0.06	–1.35	6.71	943
	FR	1.58	1.59	1.69	1.34	0.06	–0.86	3.77	159
	PR	1.81	1.82	1.89	1.62	0.04	–1.55	7.06	1,168

Notes: Med: median; Max: maximum; Min: minimum; Std: standard deviation; Skew: skewness; Kur: kurtosis; JB: Jarque Bera.
SP: stock price; ER: economic risk; FR: financial risk; PR: political risk; BRICS: Brazil, Russia, India, China and South Africa.
The values reported here are the natural logs of the variables. We used natural log forms in our estimation.

Table 2 Correlation matrix

Country	*Variables*	*SP*	*ER*	*FR*	*PR*
Model 1: Individual country case					
Brazil	SP	1.00			
	ER	0.78*	1.00		
	FR	0.48*	0.28	1.00	
	PR	0.31	0.19	0.24	1.00

Notes: SP: stock price; ER: economic risk; FR: financial risk; PR: political risk; BRICS: Brazil, Russia, India, China and South Africa.
* indicates statistical significance at a 1% level; and
** indicates statistical significance at a 5% level.

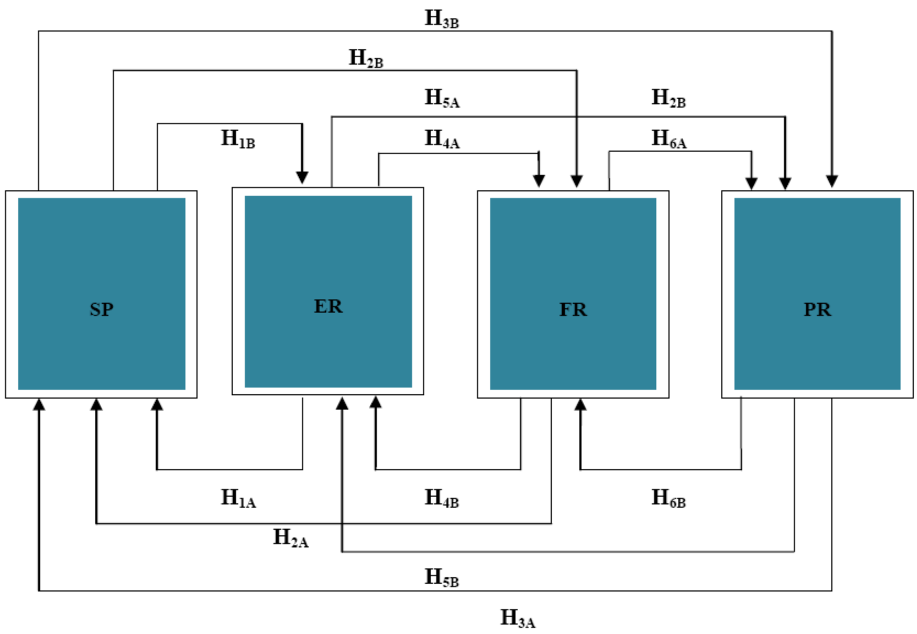
Table 2 Correlation matrix (continued)

Country	*Variables*	*SP*	*ER*	*FR*	*PR*
		Model 1: Individual country case			
Russian Federation	SP	1.00			
	ER	0.52*	1.00		
	FR	0.86*	0.64	1.00	
	PR	0.69*	0.54	0.70	1.00
India	SP	1.00			
	ER	0.15	1.00		
	FR	0.61*	0.51*	1.00	
	PR	0.37**	0.74*	0.47*	1.00
China	SP	1.00			
	ER	0.58*	1.00		
	FR	0.70*	0.32**	1.00	
	PR	–0.12	–0.01	–0.11	1.00
South Africa	SP	1.00			
	ER	0.01	1.00		
	FR	0.50*	0.05	1.00	
	PR	0.05	0.05	0.40*	1.00
		Model 2: Panel case			
BRICS	SP	1.00			
	ER	0.06	1.00		
	FR	–0.20	0.53*	1.00	
	PR	0.44*	0.41*	0.25	1.00

Notes: SP: stock price; ER: economic risk; FR: financial risk; PR: political risk;
BRICS: Brazil, Russia, India, China and South Africa.
* indicates statistical significance at a 1% level; and
** indicates statistical significance at a 5% level.

Figure 1 presents the possible patterns of causal relations between stock prices and risk ratings (ER, FR and PR) in the BRICS countries, both individually and collectively. In this study, the test for the *risk ratings-led stock price hypothesis* and its counterpart, the *stock price-led risk ratings hypothesis*, was performed in three steps: tests for the order of integration, tests for cointegration, and tests for Granger causality. We conducted these three sets of tests at both the individual country level and at the panel level, based on the cluster of five countries. Detailed discussions of these tests are presented below.

Figure 1 Proposed model and hypotheses (see online version for colours)



Notes: SP: stock price; ER: economic risk; FR: financial risk; PR: political risk.
H_{1A}: ER Granger causes SP; H_{1B}: SP Granger causes ER; H_{2A}: FR Granger causes SP; H_{2B}: SP Granger causes FR; H_{3A}: PR Granger causes SP; H_{3B}: SP Granger causes PR; H_{4A}: ER Granger causes FR; H_{4B}: FR Granger causes ER; H_{5A}: ER Granger causes PR; H_{5B}: PR Granger causes ER; H_{6A}: FR Granger causes PR; and H_{6B}: PR Granger causes FR.

3.1 Unit-root tests

These tests are deployed to determine the order of integration where a time series variable attains stationarity. We deployed the augmented Dickey-Fuller (ADF) test developed by Dickey and Fuller (1981) and the Phillips and Perron (PP) test (Phillips and Perron, 1988) for the individual country analysis, and the Levin-Lin-Chu (LLC) test (Levin et al., 2002) and the Im-Pesaran-Shin (IPS) test (Im et al., 2003) at the panel setting. The results of the ADF and PP tests are not discussed here, due to space constraints, but the results of the LLC and IPS tests are presented below.

Both the LLC and IPS tests are widely used, and are consistent with the ADF approach. The LLC test assumes homogeneity in the dynamics of the autoregressive coefficients for all panel values, while the IPS test assumes heterogeneity in these dynamics. Therefore, the IPS test is known also as the 'heterogeneous panel unit root test'.

The LLC test is a panel-based ADF test, which restricts γ_i to keep it identical across cross-sectional countries. The subscript 'i' on the intercept term suggests that the intercepts of the countries may be different. The test supposes homogeneity of the autoregressive coefficient (β) to indicate the presence or absence of a unit root, whereas the intercept and trend can vary across individual series. The model allows heterogeneity only in relation to the intercept, and can be represented as follows:

$$\Delta Y_{i,t} = \alpha_i + \gamma_i Y_{i,t-1} + \sum_{j=1}^{p_i} \beta_j \Delta Y_{i,t-j} + \varepsilon_{i,t} \qquad (1)$$

where $Y_{i,t}$ is a time series for panel member (country) i (i = 1, 2,..N) over period t (t = 1, 2,…,T), and p_i is the number of lags in the ADF regression. The error term ($\varepsilon_{i,t}$) is assumed to be independently and identically distributed [IID] (0, σ^2), and independent across the members of the sample. The model allows for fixed effects, unit-specific time trends and common time effects. The coefficient (β_j) of the lagged dependent variable is restricted to be homogenous across all units of the panel. Hence, the null hypothesis of non-stationarity is stated as:

$$\text{H}_0: \gamma_i = 0, \text{ and is tested against the alternative } \text{H}_\text{A}: \gamma_i = \gamma < 0 \text{ for all } i \qquad (2)$$

where the fixed effect model in equation (1) is based on the usual t-statistics.

$$t_\gamma = \frac{\widehat{\gamma}}{s.e(\widehat{\gamma})} \qquad (3)$$

where γ is restricted by being kept identical across regions under both the null and the alternate hypotheses.

The IPS test arises from separate ADF regression for each cross section (country) member:

$$\Delta Y_{i,t} = \alpha_i + \gamma_i Y_{i,t-i} + \sum_{j=1}^{p_i} \beta_{i,j} \Delta Y_{i,t-j} + \varepsilon_{i,t} \qquad (4)$$

where series $Y_{i,t}$ (i = 1, 2,…,N; t = 1, 2,…,T) is the time series for the panel member (country/region) i over period t, p_i is the number of lags in the ADF regression, and the error terms $\{\varepsilon_{i,t}\}$ are assumed to be IID $(0, \sigma_i^2)$ for all i and t. Both γ_i and the lag order $\beta_{i,j}$ in equation (4) are allowed to vary across sections (countries). IPS relaxes the assumption of homogeneity of the coefficient(s) of the lagged dependent variable. It appraises the null hypothesis that each time series in the panel has a unit root (in other words, its first differences are stationary) for all cross-section units against the alternative hypothesis that at least one of the series is stationary.

$$\text{H}_0: \gamma_i = 0 \text{ is tested against the alternative } \text{H}_\text{A}: \gamma_i = \gamma_i < 0 \text{ for all } i. \qquad (5)$$

The IPS developed two test statistics and then used those respectively in the LM-bar and the t-bar tests. The IPS t-bar statistic is calculated using the average of the individual Dickey-Fuller τ statistic shown below.

$$\bar{t} = \frac{1}{N} \sum_{i=1}^{N} \tau_i \qquad (6)$$

$$\tau_i = \frac{\widehat{\gamma}_i}{s.e(\widehat{\gamma}_i)} \qquad (7)$$

Assuming that the cross-section, time-series data are independent of each other, the IPS test uses the standardised t-bar statistic,

$$\overline{Z} = \frac{\sqrt{N}\left(\overline{t} - E(\overline{t})\right)}{\sqrt{Var(\overline{t})}} \tag{8}$$

The terms $E(\overline{t})$ and $Var(\overline{t})$ are the mean and variance of the τ statistic respectively. These statistics are generated by simulation and their critical values are tabulated by Im et al. (2003).

In addition to above, we have also applied Zivot and Andrews (1992) and Westerlund (2005) tests for checking structural breaks in the time series data for individual country and the panel of BRICS respectively. The discussions of these tests are not available here due to space constraints.

3.2 *Cointegration tests*

The concept of cointegration introduced by Granger (see, for example, Granger, 1981) is relevant to the problem of determining long-run relationships between variables. The basic idea underlying cointegration tests is that if the difference between two non-stationary series is stationary, then the two series are cointegrated. If two or more series are cointegrated, it is possible to interpret the variables in these series as being in a long-run equilibrium relationship (Engle and Granger, 1987). Conversely, lack of cointegration suggests that variables have no long-run relationship; thus, in principle, they can move arbitrarily far away from each other.

When a collection of time-series observations becomes stationary only after being first-differenced, the individual time series might have linear combinations that are stationary without differencing. Such collections of series are usually called cointegrated (Granger, 1969). If integration of 'order one' is implied, the next step is to employ cointegration analysis in order to establish whether there is a long-run relationship among the set of such possibly 'integrated' variables. In such investigations, Johansen's vector auto regression (VAR) test of cointegration (Johansen, 1988; Johansen and Juselius, 1990) is usually deployed. VAR is a systemic approach to check for cointegration, allowing for the determination of up to r linearly independent cointegrating vectors ($r <= g - 1$, where g is the number of variables tested for cointegration). The estimated cointegration equation is the following:

$$Y_{it} = \beta_{i0} + \beta_{i1} X_{i1t} + \beta_{i2} X_{i2t} + \ldots + \beta_{ik} X_{ikt} + \varepsilon_{it} \tag{9}$$

This equation may be re-written as:

$$\varepsilon_{it} = Y_{it} - \left(\beta_{i0} + \beta_{i1} X_{i1t} + \beta_{i2} X_{i2t} + \ldots + \beta_{ik} X_{ikt}\right) \tag{10}$$

with the cointegration vector defined as:

$$\left[1 - \beta_{i0} - \beta_{i1} - \beta_{i2} \ldots - \beta_{ik}\right] \tag{11}$$

We note that, as developed by Johansen (1988), the test above could not deal with panel settings. We therefore used an enhancement, the Pedroni (2000) panel cointegration test, to test for the presence of cointegration. The Pedroni panel cointegration test was applied to the following time-series panel regression set-up:

$$Y_{i,t} = \alpha_i + \sum_{j=1}^{p_i} \beta_{ji} X_{jit} + \varepsilon_{it} \tag{12}$$

$$\varepsilon_{it} = \rho_i \varepsilon_{i(t-1)} + w_{it} \tag{13}$$

where Y_{it} and X_{jit} are the observable variables; ε_{it} represents the disturbance term from the panel regression; α_i allows for the possibility of country-specific fixed effects and the coefficients $\{\beta_{ji}\}$ allow for variation across individual countries. The null hypothesis of no cointegration of the pooled (within-dimension) estimation is:

$$\text{H}_0: \rho_i = 1 \text{ for all } i \text{ against } \text{H}_1: \rho_i = \rho < 1. \tag{14}$$

Under the first hypothesis, the within-dimensional estimation assumes a common value for ρ_i (= ρ). In brief, this procedure excludes any additional source of heterogeneity that might occur between individual country members of the panel. The null hypothesis of non-cointegration of the pooled (between-dimension) estimation is written as follows:

$$\text{H}_0: \rho_i = 1 \text{ for all } i \text{ against } \text{H}_0: \rho_i < 1. \tag{15}$$

Under the alternative hypothesis, the between-dimensional estimation does not assume a common value for $\rho_i = \rho$. It thus allows for an additional source of possible heterogeneity across individual country members of the panel.

Pedroni (2004) suggested two types of tests to determine the presence of heterogeneity of the cointegration vector. First, the test uses the within-dimension approach (a panel test). It uses four statistics, namely the panel v-statistic, the panel ρ-statistic, the panel PP-statistic and the panel ADF-statistic. These statistics pool the autoregressive coefficients across different panel members for the unit root tests to be performed on the estimated residuals. Second, the test is based on between-dimensional approaches (a group test). It includes three statistics: a group ρ-statistic, a group PP-statistic and the group ADF-statistic. These statistics are based on estimators that simply average the individually estimated autoregressive coefficients for each panel member. Next, the heterogeneous panel and heterogeneous group mean panel cointegration statistics are calculated as follows:

- Panel v-statistic

$$Z_v = \left[\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\varepsilon}_{it-1}^{2} \right]^{-1} \tag{16}$$

- Panel ρ-statistic

$$Z_\rho = \left[\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\varepsilon}_{it-1}^{2} \right]^{-1} \sum_{i=1}^{N} \sum_{t=1}^{T} L_{11i}^{-2} \left(\hat{\varepsilon}_{it-1} \Delta \hat{\varepsilon}_{it} - \hat{\lambda}_i \right) \tag{17}$$

- Panel PP-statistic

$$Z_t = \left[\hat{\sigma} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\varepsilon}_{it-1}^{2} \right]^{-0.5} \sum_{i=1}^{N} \sum_{t=1}^{T} L_{11i}^{-2} \left(\hat{\varepsilon}_{it-1} \Delta \hat{\varepsilon}_{it} - \hat{\lambda}_i \right) \tag{18}$$

- Panel ADF-statistic

$$Z_t^* = \left[\hat{s}^{*2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\varepsilon}_{it-1}^{*2} \right]^{-0.5} \sum_{i=1}^{N} \sum_{t=1}^{T} L_{11i}^{-2} \hat{\varepsilon}_{it-1}^{*} \Delta \hat{\varepsilon}_{it}^{*} \tag{19}$$

- Group ρ-statistic

$$\tilde{Z}_{\rho} = \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \hat{\varepsilon}_{it-1}^{2} \right)^{-1} \sum_{t=1}^{T} \left(\hat{\varepsilon}_{it-1} \Delta \hat{\varepsilon}_{it} - \hat{\lambda}_i \right) \tag{20}$$

- Group PP-statistic

$$\tilde{Z}_t = \sum_{i=1}^{N} \left(\hat{\sigma}^2 \sum_{t=1}^{T} \hat{\varepsilon}_{it-1}^{2} \right)^{-0.5} \sum_{t=1}^{T} \left(\hat{\varepsilon}_{it-1} \Delta \hat{\varepsilon}_{it} - \hat{\lambda}_i \right) \tag{21}$$

- Group ADF-statistic

$$\tilde{Z}_t^* = \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \hat{s}_i^2 \hat{\varepsilon}_{it-1}^{*2} \right)^{-0.5} \sum_{t=1}^{T} \left(\hat{\varepsilon}_{it-1}^{*} \Delta \hat{\varepsilon}_{it}^{*} \right) \tag{22}$$

where $\hat{\varepsilon}_{it}$ is the estimated residual appearing in equation (12) and $\hat{L}_{11i}^2$ is the estimated long-run covariance matrix for $\{\Delta\hat{\varepsilon}_{it}\}$. Similarly, $\hat{\sigma}_i^2$ and $\hat{s}_i^2\,(\hat{s}_i^{*2})$ are the long-run and contemporaneous variances for individual member country *i*. All seven tests assume the existence of an asymptotically-standard normal distribution given by the respective panel/group cointegration statistic. The panel '*v*' is a one-sided test where large positive values would mean that the null hypothesis of no cointegration has to be rejected. The remaining statistics diverge to negative infinity, which means that large negative values also mean that the null hypothesis must be rejected. Each of these tests is able to accommodate individual specific short-run dynamics, individual-specific fixed effects and deterministic trends, as well as individual-specific slope coefficients (Pedroni, 2004, 1999).

3.3 Granger causality testing

We used the Granger causality test in order to examine the possible causal nexus between risk ratings and stock prices. It is applied both at the individual country and panel setting. The traditional Granger (1988) causality was used for the individual country analysis, while panel VAR (Holtz-Eakin et al., 1988) was used at the panel setting.

For traditional Granger causality, the following two models (Model 1 and Model 2) can be used to detect the causal nexus between risk ratings and stock prices.

Model 1: If the two variables are individually integrated of order one [I(1)] and not cointegrated, then the test of causality requires the estimation of following:

$$SP_t = \eta + \sum_{j=1}^{p} \alpha_j SP_{t-j} + \sum_{j=1}^{q} \beta_j RR_{t-j} + \varepsilon_t \tag{23}$$

$$RR_t = \eta + \sum_{j=1}^{p} \alpha_j RR_{t-j} + \sum_{j=1}^{q} \beta_j SP_{t-j} + \varepsilon_t \tag{24}$$

where *SP* is the stock price and *RR* refers to the three risk ratings (economic, financial, and political).

Model 2: If the two variables are individually I(1) and cointegrated, then the test of causality requires the estimation of following:

$$\Delta SP_t = \eta + \sum_{j=1}^{p} \alpha_j \Delta SP_{t-i} + \sum_{j=1}^{q} \beta_j \Delta RR_{t-j} + \delta EC_{t-1} + \varepsilon_t \tag{25}$$

$$\Delta RR_t = \eta + \sum_{j=1}^{p} \alpha_j \Delta RR_{t-i} + \sum_{j=1}^{q} \beta_j \Delta SP_{t-j} + \delta EC_{t-1} + \varepsilon_t \tag{26}$$

where *EC* stands for error correction term and other notations are defined earlier.

However, for panel setting, we used the following two models (Model 3 and Model 4) to establish a causal nexus between risk ratings and the stock price.

Model 3: If time series variables are I(1) and not cointegrated, then the test of causality requires the estimation of the following:

$$\Delta SP_{it} = \eta_j + \sum_{k=1}^{p} \alpha_{ik} \Delta SP_{it-k} + \sum_{k=1}^{q} \lambda_{ik} \Delta RR_{it-k} + \Delta \varepsilon_{it} \tag{27}$$

$$\Delta RR_{it} = \eta_j + \sum_{k=1}^{p} \alpha_{ik} \Delta RR_{it-k} + \sum_{k=1}^{q} \lambda_{ik} \Delta SP_{it-k} + \Delta \varepsilon_{it} \tag{28}$$

Model 4: If time series variables are I(1) and cointegrated, then the direction of causality is tested by using the error correction model. The process requires the estimation of the following:

$$\Delta SP_{it} = \eta_j + \sum_{k=1}^{p} \alpha_{ik} \Delta SP_{it-k} + \sum_{k=1}^{q} \lambda_{ik} RR_{it-k} + \mu_i EC_{1it-k} + \Delta \varepsilon_{1it} \tag{29}$$

$$\Delta RR_{it} = \eta_j + \sum_{k=1}^{p} \alpha_{ik} \Delta RR_{it-k} + \sum_{k=1}^{q} \lambda_{ik} SP_{it-k} + \mu_i EC_{1it-k} + \Delta \varepsilon_{1it} \tag{30}$$

The model estimation is very sensitive to lag length. The Akaike information criterion (AIC) and Schwarz Bayesian criterion (SBC) were used to decide the optimal lag length. These criteria are expressed in the equations below and are widely used in advanced applied econometric studies:

$$AIC_k = \ln|W| + \frac{2N^2 q}{T} \tag{31}$$

$$SBC_k = \ln|W| + \frac{N^2 q}{T} \ln(T) \tag{32}$$

where W is the estimated residual covariance matrix, N is the number of equations, q is the number of coefficients per equation, and T is the sample size, all in our system with $k = 1, 2$.

4 Results and discussion

This section presents the results of the empirical analysis, together with a discussion of their implications for evidence of causality between risk ratings and stock prices. The discussion starts with the issue of stationarity. Using the unit root test (the ADF and PP tests at the individual country level and the LLC and IPS tests at the panel setting), we rejected the null hypothesis of the unit root at the first difference, but not for the levels, at a 5% level of significance (see Table 3; Model 1 and Model 2 respectively). This indicates that the risk ratings (ER, FR, and PR) and stock prices (SP) were non-stationary at the level data, but we found stationarity at the first difference. This is true for all five BRICS countries, both individually and collectively (thus at the panel setting).

Table 3 Unit root test statistics

Country	*Variables*	*Individual country unit root test*							
		ADF test			*PP test*			*ZA test*	
		LD	*FD*	*Conclusion*	*LD*	*FD*	*Conclusion*	*t-stat*	*Break points*
Model 1: Individual country case									
Brazil	SP	–0.79	–13.4*	I [1]	–0.86	–13.4*	I [1]	–3.82	January, 2001
	ER	–2.60	–15.0*	I [1]	–2.73	–15.1*	I [1]	–4.04	August, 1997
	FR	–2.31	–16.9*	I [1]	–2.21	–16.9*	I [1]	–5.92**	November, 1998
	PR	–3.10	–14.3*	I [1]	–3.45	–14.3*	I [1]	–5.55*	November, 1998
Russian Federation	SP	–1.50	–10.9*	I [1]	–1.34	–11.1*	I [1]	–3.76	March, 1998
	ER	–2.19	–13.8*	I [1]	–2.23	–13.8*	I [1]	–3.91	December, 1999
	FR	–2.01	–10.9*	I [1]	–2.10	–11.7*	I [1]	–4.10	September, 2000
	PR	–2.08	–13.4*	I [1]	–2.26	–13.5*	I [1]	–4.14	April, 2000

Notes: ADF: augmented Dickey-Fuller test; PP: Phillips and Perron test; LLC: Levine-Lin-Chu test; IPS: Im-Pessaran-Shin test; ZA: Zivot and Andrew test; LM: Westerlund test; LD: level data; FD: first difference data; BRICS: Brazil, Russia, India, China and South Africa; I[1]: integrated of order one. SP: stock price; ER: economic risk; FR: financial risk; PR: political risk. ** and * indicate statistical significance at a 1% and 5% level respectively.

Table 3 Unit root test statistics (continued)

Country	Variables	*Individual country unit root test*							
		ADF test			*PP test*			*ZA test*	
		LD	*FD*	*Conclusion*	*LD*	*FD*	*Conclusion*	*t-stat*	*Break points*
Model 1: Individual country case									
India	SP	–0.46	–13.1*	I [1]	–0.65	–13.1*	I [1]	–3.84	April, 2003
	ER	–1.81	–15.1*	I [1]	–2.78	–15.1*	I [1]	–4.31	May, 2008
	FR	–1.49	–13.7*	I [1]	–2.42	–13.7*	I [1]	–6.99**	May, 2003
	PR	–2.08	–15.8*	I [1]	–2.08	–15.9*	I [1]	–3.88	November, 2003
China	SP	–2.19	–15.2*	I [1]	–2.24	–15.2*	I [1]	–4.37	March, 1996
	ER	–1.93	–14.2*	I [1]	–2.20	–14.2*	I [1]	–4.97	April, 1995
	FR	–2.57	–14.4*	I [1]	–2.18	–14.6*	I [1]	–8.18**	April, 1997
	PR	–2.80	–15.8*	I [1]	–2.01	–15.8*	I [1]	–5.00*	November, 2001
South Africa	SP	–0.25	–12.3*	I [1]	–0.25	–12.9*	I [1]	–3.55	March, 2003
	ER	–2.50	–14.5*	I [1]	–2.51	–14.7*	I [1]	–4.19	November, 2008
	FR	–2.65	–13.9*	I [1]	–2.78	–13.9*	I [1]	–5.25*	April, 2002
	PR	–2.07	–12.0*	I [1]	–2.22	–12.0*	I [1]	–4.35	April, 2003

		Panel unit root test						
		LLC test			*IPS test*			*LM test*
		LD	*FD*	*Conclusion*	*LD*	*FD*	*Conclusion*	
Model 2: Panel case								
BRICS	SP	1.06	–10.7*	I [1]	1.38	–13.3*	I [1]	–5.75**
	ER	–1.48	–9.84*	I [1]	–2.12	–12.5*	I [1]	–6.18**
	FR	–1.66	–13.9*	I [1]	–2.14	–196*	I [1]	–6.32**
	PR	–0.04	–13.8*	I [1]	–1.94	–191*	I [1]	–6.18**

Notes: ADF: augmented Dickey-Fuller test; PP: Phillips and Perron test; LLC: Levine-Lin-Chu test; IPS: Im-Pessaran-Shin test; ZA: Zivot and Andrew test; LM: Westerlund test; LD: level data; FD: first difference data; BRICS: Brazil, Russia, India, China and South Africa; I[1]: integrated of order one. SP: stock price; ER: economic risk; FR: financial risk; PR: political risk. ** and * indicate statistical significance at a 1% and 5% level respectively.

It can be noted that the unit root tests discussed above (such as ADF, PP, LLC and IPS) might provide biased results regarding the order of integration when data show structural breaks in the series. To deal with this issue, we utilised the Zivot and Andrews (1992) for individual country and Westerlund (2005) for panel analysis to check the structural-breaks in the process of stationarity issue. Table 3 (see last column) reports the results of these tests. The results show the presence of structural breaks in the stationarity process. However, in most of the cases, the breaks points are not statically significant. Therefore, we can declare that all variables (risk ratings and stock prices) are I(1) and that supports the validity of using ADF, PP, LLC and IPS tests. This suggests that risk ratings and stock prices are integrated of order one [i.e., I(I)] and suggests the possibility of cointegration between the two.

In the next step, we deployed the Johansen maximum likelihood cointegration test (λ_{Tra} and λ_{Max}) at the individual country level and the Pedroni (and Fisher's) panel cointegration test at the panel setting to establish the existence of cointegration between risk ratings and stock prices. The results of both the statistics are reported in Table 4 (as Models 1 and 2, respectively). The results indicate that the variables under review were cointegrated (both at the individual level and at the panel setting), indicating the existence of a long-run association between risk ratings and stock prices.

Table 4 Results of cointegration test

Country	*λ-Tra*				*λ-Max*				*Conclusion*
	Null hypothesis				*Null hypothesis*				
	r = 0	*r ≤ 1*	*r ≤ 2*	*r ≤ 3*	*r = 0*	*r ≤ 1*	*r ≤ 2*	*r ≤ 3*	
Model 1: Individual country case									
Brazil	50.2*	27.0	8.83	0.42	33.2*	18.2	8.41	0.42	(1)
Russian Federation	44.4	23.95	8.86	1.96	20.5	15.1	6.90	1.96	(0)
India	55.3*	27.3**	3.56	0.76	27.9*	23.7**	2.80	0.76	(2)
China	69.2*	30.9**	8.59	1.05	38.3*	22.3**	7.54	1.05	(2)
South Africa	48.6*	14.6	7.05	0.05	30.1**	7.51	7.00	0.05	(1)
Model 2: Panel case									
Case 1: Fisher's panel cointegration test									
BRICS	63.0*	22.3**	13.3	12.2	53.4*	17.1**	12.5	12.2	(2)

Case 2: Pedroni panel cointegration test

Test statistics	*Calculated value*	*Probability*
Panel v-statistic	0.672	[0.25]
Panel ρ-statistic	–1.52**	[0.05]
Panel PP-statistic	–1.37***	[0.08]
Panel ADF-statistic	–1.38***	[0.08]
Group ρ-statistic	–0.80	[0.21]
Group PP-statistic	–1.07	[0.14]
Group ADF-statistic	–0.99	[0.16]

Notes: SP: stock price; ER: economic risk; FR: financial risk; PR: political risk;
BRICS: Brazil, Russia, India, China and South Africa.
* indicates statistical significance at a 5% level; and
** indicates statistical significance at a 10% level.

Having found confirmation of the cointegration between risk ratings and stock prices, the next step was to check their direction of causality. Using Granger causality, the estimated results (see Table 5) suggest the following:

Table 5 Results of VECM causality

Country	*DV*	*Independent variables*					*Inferences*
		ΔSP	*ΔER*	*ΔFR*	*ΔPR*	ECT_{t-1}	
Model 1: Individual country case							
Brazil	SP	----	0.90	0.30	0.63	–0.15	
	ER	1.22	----	0.47	0.70	1.24	
	FR	9.82*	5.14*	----	1.10	2.79	SP => FR; ER => FR
	PR	0.56	4.89*	6.96*	----	–3.91*	ER => PR; FR => PR
Russian Federation	SP	----	1.14	2.02	0.57	-----	
	ER	3.44**	----	12.1*	22.6*	-----	FR => ER; PR => ER
	FR	19.8*	0.67	----	35.1*	-----	SP => FR; PR => FR
	PR	13.2*	6.46*	2.84	----	-----	SP => PR; ER => PR
India	SP	----	3.97**	7.93*	4.93**	–3.17*	ER => SP; FR => SP; PR => SP
	ER	1.32	----	0.61	0.74	1.56	
	FR	1.56	1.17	----	1.96	3.63	
	PR	0.89	3.88*	2.17	----	3.10	ER => PR
China	SP	----	4.14**	0.99	0.43	–2.95**	FR => SP
	ER	3.74**	----	0.42	3.88**	2.32	FR => ER; PR => ER
	FR	10.3*	3.92*	----	2.32	-4.73	SP => FR; ER => FR
	PR	2.67	0.24	1.03	----	–3.24	
South Africa	SP	----	0.20	3.85**	0.74	–1.06	FR => SP
	ER	0.30	----	1.45	3.88**	–1.31	PR => ER
	FR	11.0*	0.23	----	3.50**	4.77	SP => FR; PR => FR
	PR	2.38	1.80	14.5*	----	–1.03	FR => PR
Model 2: Panel case							
BRICS	SP	----	7.71*	0.25	5.26*	–1.99	ER => SP; PR => SP
	ER	5.54*	----	8.61*	29.9*	5.12	SP => ER; FR => ER; PR => ER
	FR	60.1*	1.95	----	13.0*	–2.32	SP => FR; PR => FR
	PR	17.7*	5.42*	4.54*	----	–5.70	SP => PR; ER => PR; FR => PR

Notes: SP: stock price; ER: economic risk; FR: financial risk; PR: political risk;
ECT: error correction term; BRICS: Brazil, Russia, India, China and South Africa.
* indicates statistical significance at a 1% level; and
** indicates statistical significance at a 10% level.

For Brazil, there was unidirectional causality from stock price to financial risk, economic risk to financial risk, economic risk to political risk, and financial risk to political risk.

For Russia, we found bidirectional causality between political risk and economic risk, and unidirectional causality from stock price to financial risk, stock price to political risk, political risk to financial risk, and financial risk to economic risk.

For India, there was evidence of unidirectional causality from economic risk to stock price, financial risk to stock price, and political risk to stock price.

For China, we found bidirectional causality between stock prices and economic risk, and between financial risk and economic risk. We also noted the presence of unidirectional causality from political risk to economic risk.

For South Africa, we found the presence of bidirectional causality between stock prices and financial risk, and between financial risk and political risk. Unidirectional causality from political risk to economic risk was also present.

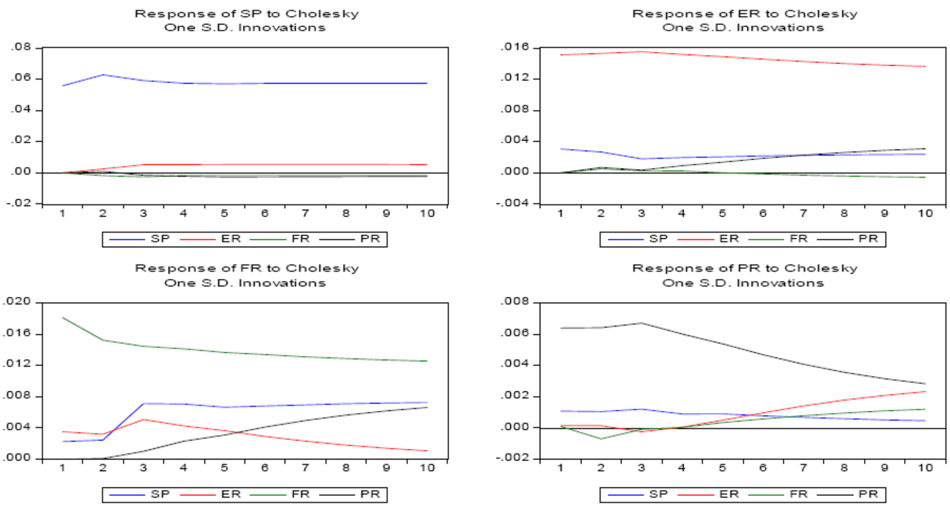
At the panel level (for BRICS as a whole), we found evidence of bidirectional causality between economic risk and stock prices, between political risk and stock prices, between financial risk and political risk, and between political risk and economic risk. In addition, we found unidirectional causality from financial risk to economic risk and from stock price to economic risk. The above results are summarised in Table 6.

Table 6 The summary of granger causality between risk ratings and stock prices in the five BRICS countries

Causal relationships tested in the model	*Direction of relationships observed in brazil*	*Direction of relationships observed in Russian Federation*	*Direction of relationships observed in India*	*Direction of relationships observed in China*	*Direction of relationships observed in South Africa*	*Direction of relationships observed in panel level*
SP vs. ER	NA	NA	ER => SP	NA	NA	ER <=> SP
SP vs. FR	SP => FR	SP => FR	FR => SP	FR <=> SP	FR <=> SP	SP => FR
SP vs. PR	NA	SP => PR	PR => SP	NA	NA	PR <=> SP
ER vs. FR	ER => FR	FR => ER	NA	ER <=> FR	NA	FR => ER
ER vs. PR	ER => PR	PR <=> ER	ER => PR	PR => ER	PR <=> ER	PR <=> ER
FR vs. PR	FR => PR	PR => FR	NA	NA	FR => PR	PR <=> FR

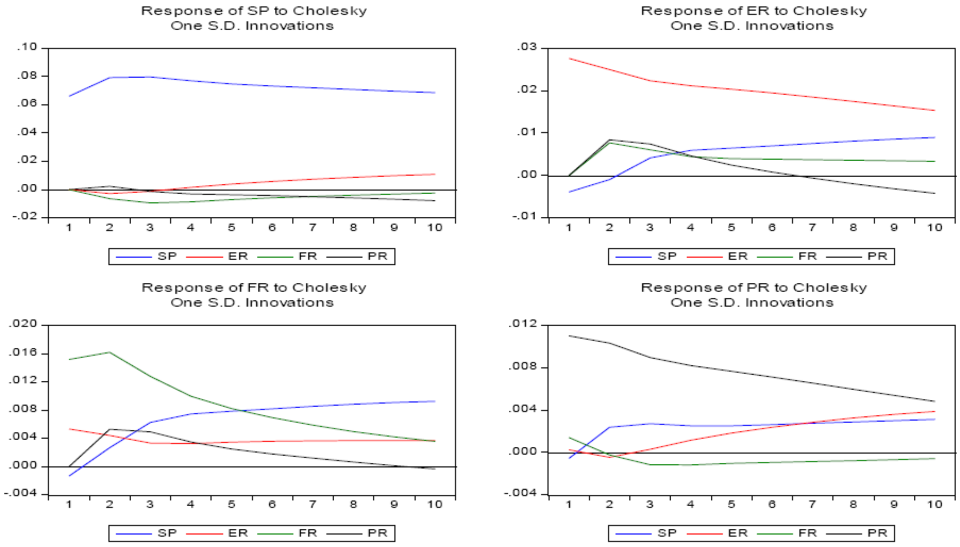
Notes: SP: stock price; ER: economic risk; FR: financial risk; and PR: political risk
=> unidirectional causality; <=>: bidirectional causality; and NA: no causality

Figure 2 Granger causal relations between SP, ER, FR, PR in Brazil (see online version for colours)



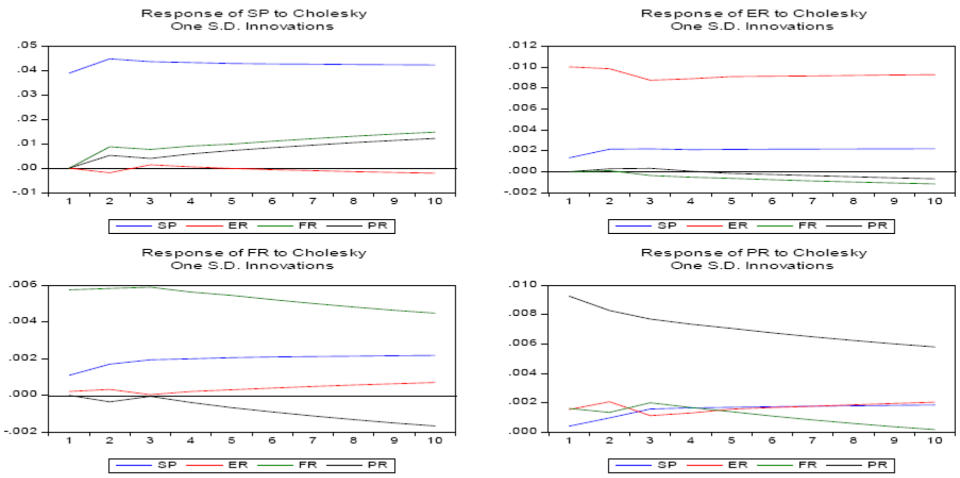
Notes: SP: stock price; ER: economic risk; FR: financial risk; PR: political risk.

Figure 3 Granger causal relations between SP, ER, FR, PR in Russia (see online version for colours)



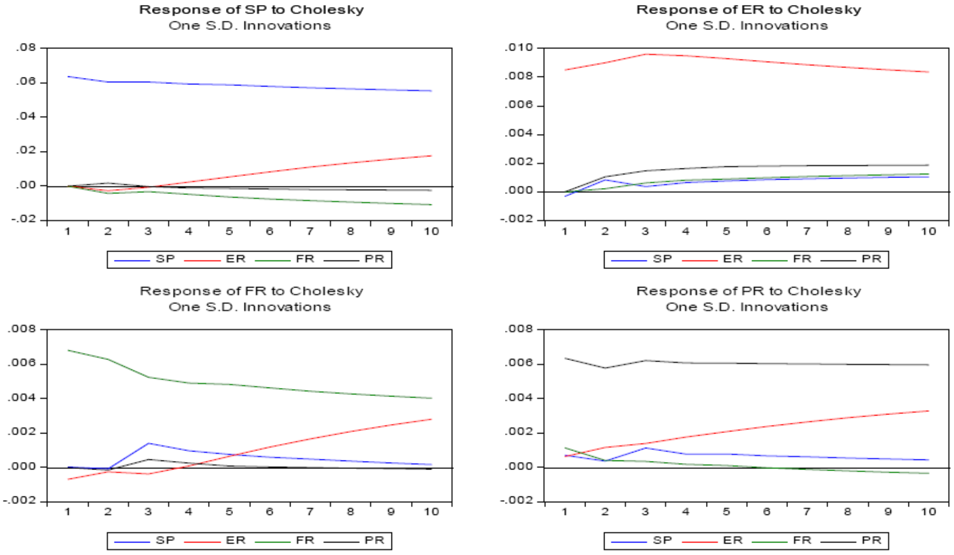
Notes: SP: stock price; ER: economic risk; FR: financial risk; PR: political risk.

Figure 4 Granger causal relations between SP, ER, FR, PR in India (see online version for colours)



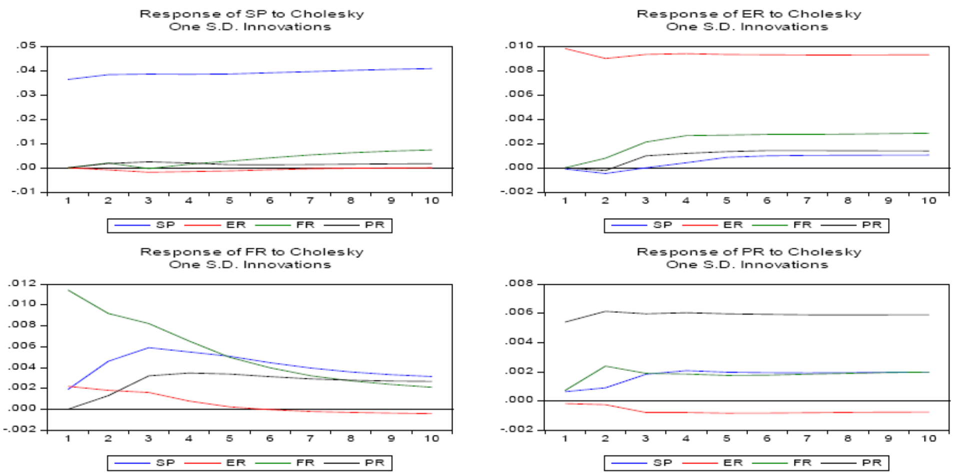
Notes: SP: stock price; ER: economic risk; FR: financial risk; PR: political risk.

Figure 5 Granger causal relations between SP, ER, FR, PR in China (see online version for colours)



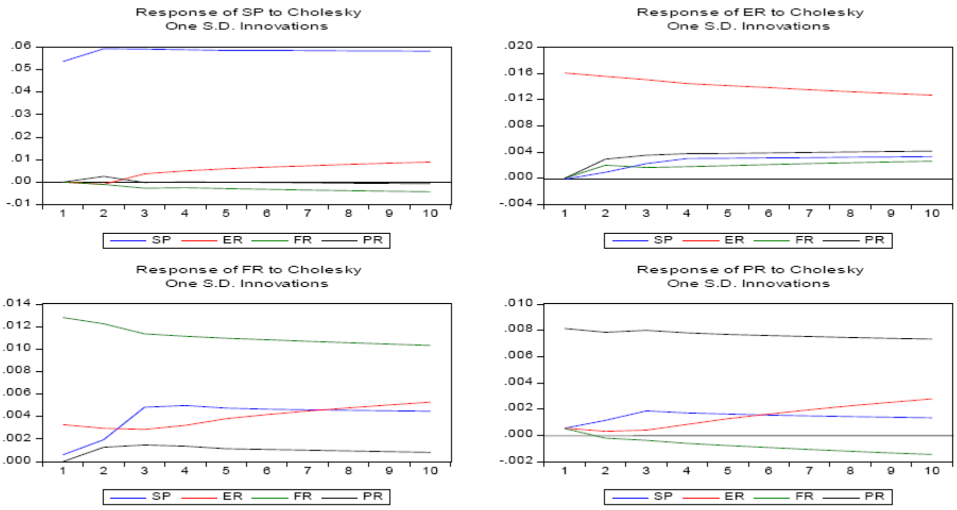
Notes: SP: stock price; ER: economic risk; FR: financial risk; PR: political risk.

Figure 6 Granger causal relations between SP, ER, FR, PR in South Africa (see online version for colours)



Notes: SP: stock price; ER: economic risk; FR: financial risk; PR: political risk.

Figure 7 Granger causal relations between SP, ER, FR, PR in BRICS (see online version for colours)



Notes: SP: stock price; ER: economic risk; FR: financial risk; PR: political risk; BRICS: Brazil, Russia, India, China and South Africa.

Finally, to complement our analysis, we employed generalised impulse response functions (GIRFs) to trace the effect of a one-off shock to one of the innovations on the current and future values of the endogenous variables. The generalised impulse responses offer additional insight into how shocks to each risk rating can affect and can be affected by stock prices. These results are illustrated in the graphs in Figures 2 to 7, one for each of our samples. This analysis provides additional support for the argument that there is demonstrable causality among the variables on our VECM model.

5 Conclusions and policy implications

This study investigated the causal relations among risk ratings (economic risk, financial risk and political risk) and stock prices in the five BRICS countries for the period from 1992 to 2012. The nexus between these five macro-economic entities is intriguing and of great interest to policymakers. Using a state-of-the art cointegration test and Granger causality, this study reached the following conclusions: firstly, risk ratings (economic, financial and political) and stock prices are integrated of order one for the five BRICS countries, both individually and as a group. Secondly, the cointegration test confirms the existence of a long-run equilibrium relationship between stock prices and individual risk ratings. Thirdly, the Granger causality test confirms the presence of a multitude of causal relations between the three risk ratings (economic risk, financial risk, and political risk) and stock prices. In particular, the study found both feedback and unidirectional causal relations between risk ratings and stock prices. However, the findings differed from country to country in the panel of BRICS countries. The findings suggest that stock prices accelerate the pace of risk ratings of these five countries and vice versa. The results of this study indicate that for the BRICS countries, changes in risk ratings, as determined by credit rating agencies, contribute to instability in the stock markets.

The policy implications of these empirical findings are clear and could be discussed on the basis of the number of occurrences of the causalities. Firstly, political risk plays a big role in Russia where three causalities between political risk and various other factors were found. Brazil and South Africa have both two causalities between political risk and other factors. The implications of this for prospective investors are that extra caution should be taken when contemplating investing in these countries. One recognise that it could take years for a political dispensation to change in these countries, but any change in political stability could have serious effects on financial and stock market returns for investors. Secondly, in India there was three causalities between stock prices and other factors, the highest number than in any other country. The implication of this finding is that the importance of the stock market in India should move political and economic policymakers to take this relation into account in their policy applications. Thirdly, the highest numbers of causalities, namely five, were found in Russia. Whilst it could be controversial (and therefore we will refrain from doing so) to speculate about possible reasons for this finding, it clearly indicate towards a higher risk factor when investing in this country. However, higher risk could bring a higher return, and investors with a high enough risk appetite could find corresponding higher returns from investing in the Russian stock market.

The general policy implications of the empirical findings of this study indicates that if policy-makers want to promote financial stability, political steadiness and economic prosperity, they should focus more on the long-run relationships between stock price and risk assessments (economic risk, financial risk and political risk). This requires them to put in place well-developed economic, political and financial systems, particularly in respect of sound governmental policies regarding public debt, international liquidity, exchange rate stability (capital and currency controls), trade openness, long-run financial contracts and the use of sophisticated hedging techniques.

This study opens up a number of avenues for further research. The study can be complemented by an investigation of the impact of changes in risk on specific stock market sectors (industries) – it can be hypothesised that some industries have an inelastic demand for their products, and would therefore be less affected by changing risk. In addition, instead of examining the effect of changing risk on the total stock market, the influence of changing risk on variables such as equity returns, dividend yield, price earnings ratios or price/book value ratios could be investigated.

Acknowledgements

Rudra P. Pradhan would like to thank the School of Management, Asian Institute of Technology Bangkok for providing academic infrastructure to prepare the IEEE conference paper. The author would also like to thank Professors S. Hammoudeh, R. Sari, M. Uzunkaya and T. Liu for sharing their data file.

Flávio de São Pedro Filho would like to thank the Indian Institute of Technology, Kharagpur (India), University of Pretoria, Pretoria (South Africa), Ekiti State University, Ado-Ekiti (Nigeria) and Federal University of Rondônia, Brazil. Special thanks to Professor Dr. José Moreira da Silva Neto and his student Master Candidate Jeoval Batista da SILVA by his collaboration to success of the research group.

References

Adler, M. and Simon, D. (1986) 'Exchange risk surprise in international portfolios: some equity markets are super-nominal', *Journal of Portfolio Management*, Vol. 12, No. 2, pp.44–53.

Aggarwal, C., Inclan, C. and Lean, R. (1999) 'Volatility in emerging stock markets', *Journal of Financial Quantitative Analysis*, Vol. 34, No. 1, pp.33–55.

Biggemann, S. and Fam, K. (2011) 'Business marketing in BRIC countries', *Industrial Marketing Management*, Vol. 40, No. 1, pp.5–7.

Brooks, R., Faff, R., Hillier, D. and Hillier, J. (2004) 'The national market impact of sovereign rating changes', *Journal of Banking and Finance*, Vol. 28, No. 1, pp.233–250.

Cheng, H.F., Gutierrez, M., Mahajan, A., Shachmurove, Y. and Shahrokhi, M. (2007) 'A future global economy to be built by BRICs', *Global Finance Journal*, Vol. 18, No. 2, pp.143–156.

Clark, E. and Kassimatis, K. (2004) 'Country financial risk and stock market', *Journal of Economics and Business*, Vol. 56, No. 1, pp.21–41.

Diamonte, R.L., Liew, J.M and Stevens, R.L. (1996) 'Political risk in emerging and developed markets', *Financial Analysts Journal*, Vol. 52, No. 3, pp.71–76.

Dickey, D.A. and Fuller, W.A. (1981) 'Likelihood ratio statistics for autoregressive time series with a unit root', *Econometrica*, Vol. 49, No. 4, pp.1057–1072.

Engle, R.F. and Granger, C.W.J. (1987) 'Cointegration and error correction: representation, estimation and testing', *Econometrica*, Vol. 55, No. 2, pp.251–276.

Enisan, A.A. and Olufisayo, A.O. (2009) 'Stock market development and economic growth: evidence from seven Sub-Saharan African countries', *Journal of Economics and Business*, Vol. 61, No. 2, pp.162–171.

Ephraim, C. (1997) 'Valuing political risk', *Journal of International Money, and Finance*, Vol. 16, No. 3, pp.484–485.

Erb, C.B., Harvey, C.R. and Viskanta, T.E. (1996) 'The influence of political, economic and financial risk on fixed income returns', *Journal of Fixed Income*, Vol. 6, No. 1, pp.7–30.

Esqueda, O.A., Assefa, T.A. and Mollick, A.V. (2002) 'Financial globalization and stock market risk', *Journal of International Financial Markets, Institutions and Money*, Vol. 22, No. 1, pp.87–102.

Fang, H. and Loo, C.H. (1994) 'Dollar value and stock returns', *International Review of Economics and Finance*, Vol. 3, No. 2, pp.221–231.

Granger, C. (1969) 'Investigating causal relations by econometric models and cross spectral methods', *Econometrica*, Vol. 37, No. 3, pp.424–438.

Granger, C.W.J. (1981) 'Some properties of time series data and their use in econometric model specification', *Journal of Econometrics*, Vol. 16, No. 1, pp.121–130.

Granger, C.W.J. (1988) 'Some recent developments in a concept of causality', *Journal of Econometrics*, Vol. 39, Nos. 1–2, pp.199–211.

Hammoudeh, S., Sari, R., Uzunkaya, M. and Liu, T. (2013) 'The dynamics of BRICS's country risk ratings and domestic stock markets, US stock market and oil price', *Mathematics and Computers in Simulation*, Vol. 94, No. 1, pp.277–294.

Holtz-Eakin, D., Newey, W. and Rosen, H.S. (1988) 'Estimating vector auto regressions with panel data', *Econometrica*, Vol. 56, No. 6, pp.1371–1395.

Im, K.S., Pesaran, M.H. and Shin, Y. (2003) 'Testing for unit roots in heterogeneous panels', *Journal of Econometrics*, Vol. 115, No. 1, pp.53–74.

International Monetary Fund (2013) *World Economic Outlook Database*, International Monetary Fund, Washington DC.

Johansen, S. (1988) 'Statistical analysis of cointegration vectors', *Journal of Economic Dynamics and Control*, Vol. 12, Nos. 2–3, pp.231–254.

Johansen, S. and Juselius, K. (1990) 'Maximum likelihood estimation and inference on cointegration with application to the demand for money', *Oxford Bulletin of Economics and Statistics*, Vol. 52, No. 2, pp.169–210.

Kim, H.Y. and Mei, J.P. (2001) 'What makes the stock market jump? An analysis of political risk on Hong Kong stock returns', *Journal of International Money and Finance*, Vol. 20, No. 7, pp.1003–1016.

Levin, A., Lin, C.F. and Chu, C.S. (2002) 'Unit root tests in panel data: asymptotic and finite sample properties', *Journal of Econometrics*, Vol. 108, No. 1, pp.1–24.

Liu, T. (2010) *Essays in Financial Economics*, PhD Thesis, London School of Economics and Political science, London.

Markowitz, H. (1959) *Portfolio Selection: Efficient Diversification of Investment*, Wiley Publications, New York.

Muhammad, N. and Rasheed, A. (2003) 'Stock prices and exchange rates: are they related? Evidence from South Asian countries', Paper presented at the *18th Annual 18 General Meeting and Conference of the Pakistan Society of Development Economists*, January 2003, Karachi.

Pedroni, P. (1999) 'Critical values for cointegration tests in heterogeneous panels with multiple regressors', *Oxford Bulletin of Economics and Statistics*, Vol. 61, No. 1, pp.653–670.

Pedroni, P. (2000) 'Fully modified OLS for heterogeneous cointegrated panels', *Advances in Econometrics*, Vol. 15, No. 1, pp.93–130.

Pedroni, P. (2004) 'Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis: new results', *Econometric Theory*, Vol. 20, No. 3, pp.597–627.

Phillips, P.C.B. and Perron, P. (1988) 'Testing for a unit root in time series regression', *Biometrica*, Vol. 75, No. 2, pp.335–346.

Rafaqet, A. and Muhammad, A. (2012) 'Impact of global financial crisis on stock markets: evidence from Pakistan and India', *Journal of Business Management and Economics*, Vol. 3, No. 7, pp.275–282.

Solnik, B. (1987) 'Using financial prices to test exchange rate models: a note', *Journal of Finance*, Vol. 42, No. 1, pp.141–149.

Stavarek, D. (2005) 'Stock prices and exchange rates in the EU and the USA: evidence on their mutual interactions', *Czech Journal of Economics and Finance*, Vol. 55, Nos. 3–4, pp.141–161.

Vithessonthi, C. (2014) 'Financial markets development and bank risk: experience from Thailand during 1990–2012', *Journal of Multinational Financial Management*, Vol. 27, No. 3, pp.67–88.

Wang, Y., Hung, J., Kao, H. and Shih, K. (2011) 'Long-term relationship between political behaviour and stock market return: new evidence from quantile regression', *Qual. Quant.*, Vol. 45, No. 6, pp.1361–1367.

Westerlund, J. (2005) *A Panel Unit Root Test with Multiple Endogenous Breaks*, Technical Report, Lund University, Lund.

Wu, Y. (2000) 'Stock prices and exchange rates in a VEC model – the case of Singapore in the 1990s', *Journal of Economics and Finance*, Vol. 24, No. 3, pp.260–274.

Xu, H. and Hamori, S. (2012) 'Dynamic linkages of stock prices between the BRICs and the United States: effects of the 2008–09 financial crisis', *Journal of Asian Economics*, Vol. 23, No. 4, pp.344–352.

Zivot, E. and Andrews, D. (1992) 'Further evidence of great crash, the oil price shock and unit root hypothesis', *Journal of Business and Economic Statistics*, Vol. 10, No. 3, pp.251–270.