# MULTIVARIATE GARCH MODELING OF CDS RETURN VOLATILITY TRANSMISSION IN BRIC-T COUNTRIES

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**Abstract**- The importance of the volatility transmission across the international financial markets has become a current issue by the effects of global crisis in 2008. The purpose of this study is to assign the effect of the global crisis among the Credit Default Swap (CDS) risk premium volatilities in Brazil, Russia, China, South Africa and Turkey, and which country is more effective than the others in the volatility transmission. We analyze these countries' daily CDS returns for the period January 27th, 2003 – November 4th, 2014 by using a MGARCH model. The empirical results show that the CDS returns' volatility has increased during the global crisis period, the source of degree of innovation is China CDS risk premium and the source of volatility transmission is Brazil and Turkey CDS risk premiums.

**Keywords**- Credit Default Swap (CDS), Volatility Transmission, MGARCH JEL Classification: C32, F30, G15

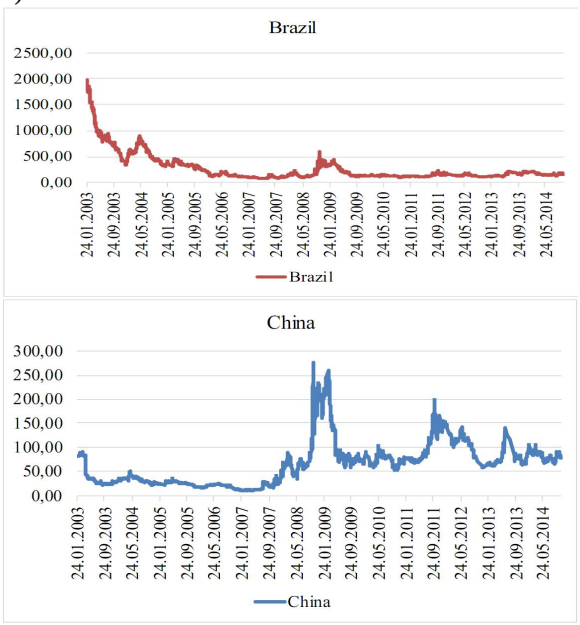
## I. INTRODUCTİON

As a result of globalization and rapid technological developments, although there are geographical borders between countries, the borders between financial markets almost disappeared and financial markets are integrated. Thus, the price movements in one financial market can spread easily and instantly to other financial markets. In literature, this is called spillover effect or contagion effect. By taking into account the integration of international financial markets, the contagion analyses have an important role to understand financial crises (Caparole et al., 2006: p.377). The global financial crisis is considered in respect of the demolition as equivalent to the Great Depression in 1929. The global financial crisis started in USA mortgage market in June 2006 and continued as a credit crisis in 2007 and in the first quarter of 2008 it turned out to be a liquidity crisis. The liquidity crisis impaired the market trust and huge financial companies started to go bankrupt. So, the crisis is named as "global financial crisis" in September 2008 and it affected the whole international financial system.

Credit default swaps (CDSs) are the most popular instrument in the rapidly-growing credit derivative markets. A CDS provides insurance against the default risk of a reference entity (usually a third party). The protection seller promises to buy the reference bond at its par value when a credit event (including bankruptcy, obligation acceleration, obligation default, failure of payment, repudiation or moratorium, or restructuring) occurs. In return, the protection buyer makes periodic payments to the seller until the maturity date of the CDS contract or until a credit event occurs. This periodic payment, which is usually expressed as a percentage (in basis points) of its notional value, is called CDS spread. Ideally, credit spread is a pure measure of the default risk of the reference entity.

CDS risk premiums have several advantages. First, CDS risk premium is a relatively pure pricing of default risk of the underlying entity. Second, Blanco et al. (2005) and Zhu (2004) show that, in the short run the CDS risk premiums tend to respond more quickly to changes in credit conditions. Finally, using CDS risk premium can avoid the confusion on which proxy to be used as risk-free rates, since they are already quoted as the differences above swap rates.

In the past decade, the credit derivatives market has experienced rapid growth, and the credit default swap (CDS) has become the most widely traded instrument for transferring credit risk (Hull, 2008). However, increasing CDS risk premiums may be a sign that the financial investors put them in the same basket with the developed ones in terms of risk level, (see Figure 1).



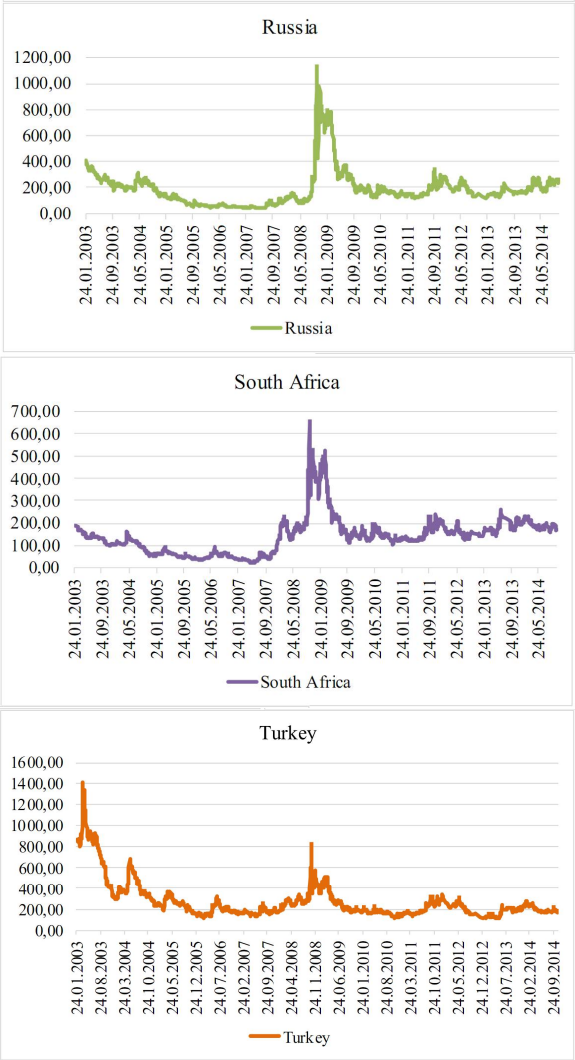



**Figure 1: Credit Default Swap Index of Sovereign Issuers**

The national and international economic, politic and/or social problems (shocks) affect especially the financial markets with high liquidity and increase the volatility of these markets. In addition to volatility, which can be stated as the fluctuation of financial asset prices lead by shocks, the degree of innovation and transmission between the markets should be emphasized.

The current value of a financial asset depends not only on its past values, but also the other financial asset's past and/or current values. In that case, it can be said that there is a volatility transmission between the financial assets. That's why, the assessment of financial assets volatility estimated only with univariate analysis lead incorrect interpretations. To reveal the volatility transmission multivariate analysis should be applied. Multivariate GARCH (MGARCH) model comes the first of the methods used for this purpose. This approach enables the decomposition of volatility transmission and degree of innovation caused by shocks which arises from both financial asset (market) own volatility and other financial assets (markets) volatilities (Worthington and Higgs, 2003: p.3; Worthington et al., 2005: p.4).

MGARCH model allows time-varying conditional variance as well as simple variance, thereby allowing for possible interaction within the conditional mean and conditional variance of two or more financial series (Wei, 2008: p.3). In brief, the movements of financial assets covariances are analyzed with this model.

In analyzed countries CDS premiums have seen remarkable increase in their values. These countries are considered as the driving force for GDP growth of the emerging economies. Having a big source of labor, natural resources and geopolitical importance these countries play an important role of global policies and influence the global economy.

The purpose of this study is to assign the effect of the global crisis among the stock return volatilities in Brazil, Russia, China, South Africa and Turkey, and which country is more effective than the others in the volatility transmission. In the following sections, a brief summary of literature is given, data set is introduced, and information about the methodology and empirical results are given respectively. In the concluding remarks section, the findings from the analysis are interpreted.

## II. LİTERATURE REVİEW

Multivariate volatilities can be used in various important financial applications. So, the application of MGARCH model is very wide and there are several studies in the literature. Some of the studies are:

- Portfolio optimization, asset allocation, calculating Value at Risk-VaR of multiple assets and futures hedging (Bauwens and Laurent 2004, Bera et al. 1997, Billio et al. 2005, Brooks et al. 2003, Hafner and Herwartz 1998, Hooy and Goh 2007, Kroner and Claessens 1991, Lien and Luo 1994, Ng 1991, Park and Switzer 1995, Rombouts and Verbeek 2004, Schröder and Schüler 2003, Yang and Allen 2004,),
- Stock returns volatility analysis between financial markets (Bekiros and Georgoutsos 2006, Caporale et al. 2000, Çiçek ve Öztürk 2007, Karolyi 1995, Engle and Colacito 2006, Engle and Sheppard 2001, Erdoğan and Schmidbauer 1997, Laurent et al. 2006, Minović 2007, 2009, Mun 2005, Polasek and Ren 2000, Scheicher 2001, Silvennoinen and Terasvirta 2008, Tai 2000, Tay and Zhu 2000, Tse 2000, Worthington and Higgs 2004,)
- Stock market sectoral analysis (Ewing and Malik 2005, Hassan and Malik 2007, Tokat 2010).
- CDS risk premium volatility transmission (Köseoğlu, 2013, Meng et al. 2009, Tokat, 2013).

3. Data and Empirical Results

3.1 Data Set

In this study, we used the Brazil, Russia, China, South Africa and Turkey's daily CDS returns; namely Brazil (BRA), Russia (RUS), China (CHN) and South Africa (SOA) and Turkey (TUR), for the period January 27th, 2003 – November 4th, 2014. The CDS

returns are calculated by log return $R_t = \ln\left(P_t / P_{t-1}\right)$ of the closing prices. Table 1 presents the descriptive statistics for each return series.

**Table 1: Descriptive Statistics**

| | BRA | RUS | CHN | SOA | TUR |
|---|---|---|---|---|---|
| Observation | 2843 | 2843 | 2843 | 2843 | 2843 |
| Mean | -0.000872 | -0.000138 | -1.66E-05 | -2.66E-05 | -0.000556 |
| Maximum | 0.357068 | 0.473613 | 0.544985 | 0.311780 | 0.389010 |
| Minimum | -0.399448 | -0.283538 | -0.638614 | -0.263477 | -0.236772 |
| Standard Deviation | 0.039616 | 0.041402 | 0.048663 | 0.036140 | 0.035547 |
| Skewness | 0.197740 | 0.871214 | 0.015055 | 0.764948 | 0.681969 |
| Kurtosis | 16.93968 | 16.06740 | 35.97919 | 13.14340 | 13.35504 |
| Jarque-Bera | 23036.71 | 20587.22 | 128838.6 | 12465.28 | 12922.30 |
| (*p*-value) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |

According to descriptive statistics, volatility, as measured by standard deviation is highest in CHN. The volatility range is between 0.048663 (CHN) and 0. 035547 (TUR). By looking at the distributional properties, we see that all of the return series have positive skewness and the kurtosis exceeds three indicating fat tails and leptokurtotic distribution. The distributional properties of the return series appear to be non-normal. Additionally, by Jarque-Bera statistic and corresponding p-value we reject the null hypothesis that returns are well approximated by the normal distribution. For this reason, in this study we used the Student-t distribution, which takes into account the fat tail problem. As well as descriptive statistics, examining the CDS return graphs in the Figure 2 shows the volatility clustering in all return series in the global crisis period.

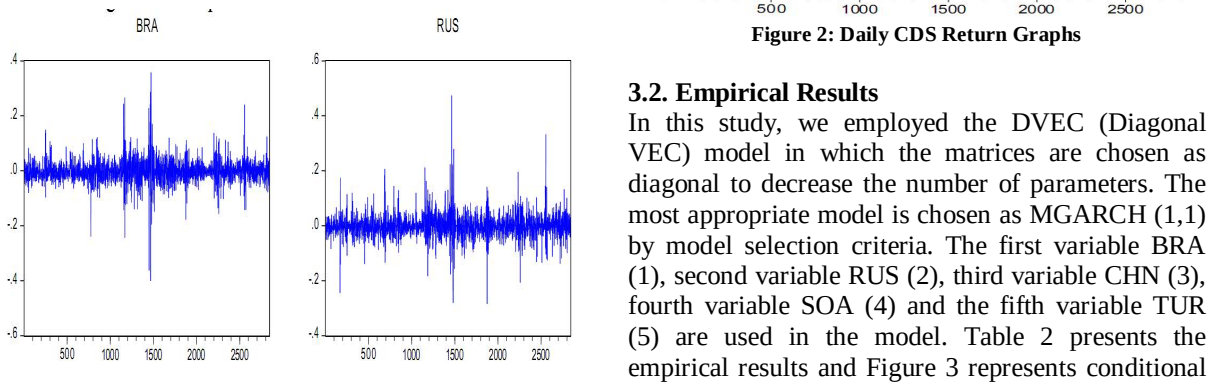



**Figure 2: Daily CDS Return Graphs**

### 3.2. Empirical Results

In this study, we employed the DVEC (Diagonal VEC) model in which the matrices are chosen as diagonal to decrease the number of parameters. The most appropriate model is chosen as MGARCH (1,1) by model selection criteria. The first variable BRA (1), second variable RUS (2), third variable CHN (3), fourth variable SOA (4) and the fifth variable TUR (5) are used in the model. Table 2 presents the empirical results and Figure 3 represents conditional covariance graphs of stock returns.

**Table 2: MGARCH (1,1)-DVEC Model Analysis Results**

| | Coefficient | Std. Error | | Coefficient | Std. Error | | Coefficient | Std. Error |
|---|---|---|---|---|---|---|---|---|
| $b_{1,1}$ | 3.31E-05 | 5.39E-06 | $cI_{1,1}$ | 0.073574 | 0.007824 | $gI_{1,1}$ | 0.908122 | 0.008600 |
| $b_{1,2}$ | 2.02E-05 | 2.94E-06 | $cI_{1,2}$ | 0.056984 | 0.005114 | $gI_{1,2}$ | 0.913652 | 0.006168 |
| $b_{1,3}$ | 1.03E-05 | 2.87E-06 | $cI_{1,3}$ | 0.039776 | 0.009041 | $gI_{1,3}$ | 0.907058 | 0.015823 |
| $b_{1,4}$ | 1.24E-05 | 2.00E-06 | $cI_{1,4}$ | 0.053406 | 0.005021 | $gI_{1,4}$ | 0.920476 | 0.006101 |
| $b_{1,5}$ | 1.77E-05 | 2.63E-06 | $cI_{1,5}$ | 0.054033 | 0.005082 | $gI_{1,5}$ | **0.920492** | 0.006052 |
| $b_{2,2}$ | 4.73E-05 | 5.31E-06 | $cI_{2,2}$ | 0.081908 | 0.006198 | $gI_{2,2}$ | 0.884496 | 0.006750 |
| $b_{2,3}$ | 1.71E-05 | 3.31E-06 | $cI_{2,3}$ | 0.044970 | 0.008380 | $gI_{2,3}$ | 0.888420 | 0.012901 |
| $b_{2,4}$ | 1.94E-05 | 2.35E-06 | $cI_{2,4}$ | 0.069697 | 0.005119 | $gI_{2,4}$ | 0.901863 | 0.005389 |
| $b_{2,5}$ | 2.58E-05 | 3.15E-06 | $cI_{2,5}$ | 0.069019 | 0.005045 | $gI_{2,5}$ | 0.902323 | 0.005497 |
| $b_{3,3}$ | 7.85E-05 | 8.74E-06 | $cI_{3,3}$ | **0.228937** | 0.018843 | $gI_{3,3}$ | 0.752817 | 0.014275 |
| $b_{3,4}$ | 1.32E-05 | 2.75E-06 | $cI_{3,4}$ | 0.043221 | 0.008032 | $gI_{3,4}$ | 0.893499 | 0.013673 |
| $b_{3,5}$ | 1.09E-05 | 2.43E-06 | $cI_{3,5}$ | 0.029743 | 0.006565 | $gI_{3,5}$ | 0.918678 | 0.011615 |
| $b_{4,4}$ | 2.30E-05 | 2.72E-06 | $cI_{4,4}$ | 0.071737 | 0.005748 | $gI_{4,4}$ | 0.905278 | 0.006175 |
| $b_{4,5}$ | 1.50E-05 | 1.96E-06 | $cI_{4,5}$ | 0.062479 | 0.004543 | $gI_{4,5}$ | 0.913994 | 0.004978 |
| $b_{5,5}$ | 3.08E-05 | 3.84E-06 | $cI_{5,5}$ | 0.069089 | 0.005609 | $gI_{5,5}$ | 0.904264 | 0.006436 |

Note: B full rank matrix, C indefinite matrix and G indefinite matrix.

Considering different matrix constraints of DVEC model, both model selection criteria as LL (Log-Likelihood), AIC (Akaike Information Criterion), BIC (Bayesian Information Criterion), H-Q (Hannan-Quinn Criterion) and parameters statistical significance, the best model is determined as DVEC Full Rank. Constant (intercept) parameters ($b_{ij}$), shows the long term averages and indicate the shocks that may affect the variable's mean but not create covariance effect. The shocks in CDS returns long term averages are negligible because of the parameters minority.

By looking at the ARCH parameters, which show "information effect" between CDS returns, all the parameters are statistically significant. The source of information effect is found to be China's CDS risk premium $c1_{3,3}$. Own-volatility spillovers in all markets are large and significant. The own-volatility spillover effects range from 0.069089 (TUR) to 0.228937 (CHN). CHN firstly and mostly affect its own volatility, and then RUS, SOA, BRA and TUR respectively. Innovations of CHN influence the volatility of other markets, and the cross-volatility spillovers are larger than the own-volatility spillovers.

The GARCH parameters indicate "volatility transmission" between CDS returns. In the GARCH set of parameters, all of the estimated coefficients are statistically significant. The source of volatility transmission is found respectively between BRA and TUR ($g1_{1,5}$), BRA and SOA ($g1_{1,4}$), CHN and TUR ($g1_{3,5}$), SOA and TUR ($g1_{4,5}$), BRA and RUS ($g1_{1,2}$). This means that the past volatility shocks have greater effect on the future volatilities between country pairs.

In GARCH models, the sum of ARCH and GARCH parameters show information about volatility persistence and whether shocks have permanent effects or not. Volatility persistence of CDS returns found very similar, respectively BRA (0.981696), CHN (0.981754), SOA (0.977015), TUR (0.973353) and RUS (0.966404). The coefficients are smaller than one, so shocks do not have permanent effect on CDS returns.

As seen in Figure 3 conditional covariance graphs below, the volatilities of all covariance between CDS returns are increased with the first signals of global crisis in the June 2006 (observations 856-876). In this context, it can be said that a shock in one countries CDS risk premium has strong information effects on other countries CDS risk premiums and strong volatility transmission is also seen. In September 2008 (observations 1437-1458), when the global crisis hit the world, the volatilities of covariance are seen between RUS-SOA at the most and between CHN-TUR at the least.

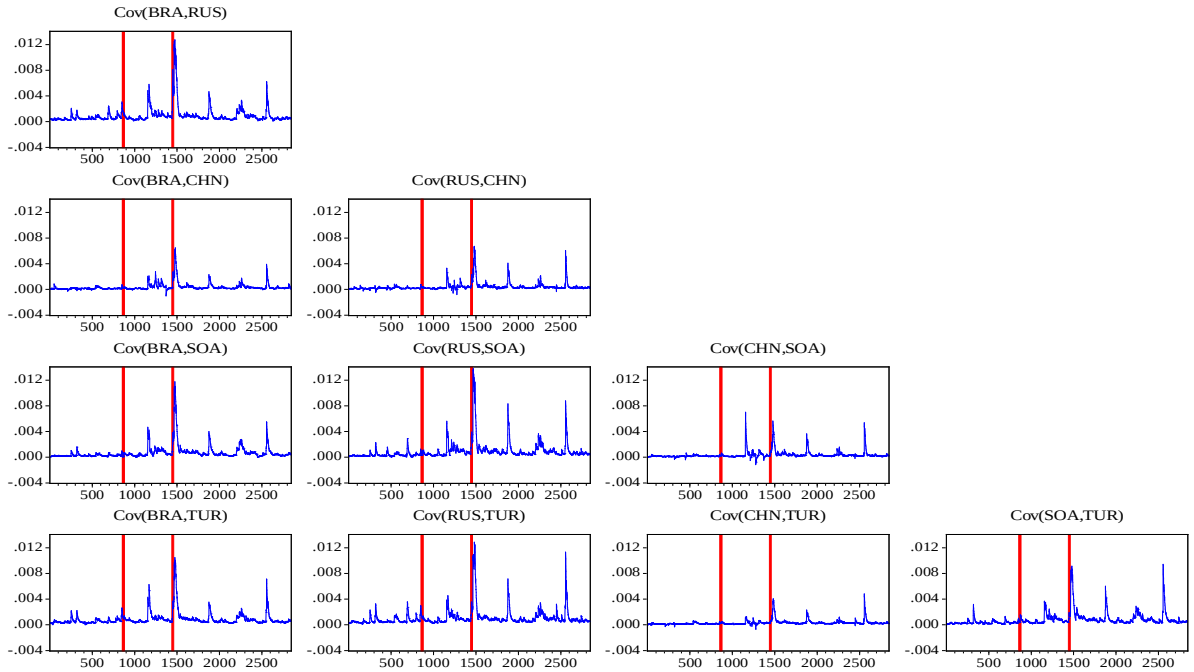



**Figure 3: Conditional Covariance Graphs**

## CONCLUDİNG REMARKS

The importance of the volatility transmission across the international financial markets has become a current issue by the effects of global crisis in 2008. By taking into account the integration of international financial markets, the contagion analyses have an important role to understand financial crises. The purpose of this study is to assign the effect of the global crisis among the CDS return volatilities in Brazil, Russia, China, South Africa and Turkey, and which country is more effective than the others in the volatility transmission. We analyze these countries' daily CDS returns for the period January 2003 - November 2014 by using a multivariate GARCH model. The most appropriate model is chosen as

MGARCH (1,1)-DVEC Full Rank by model selection criteria and model restrictions.

The empirical results show that, the CDS returns' volatility has increased during the global crisis period, the source of degree of innovation is China's CDS risk premium (c13,3) and the source of volatility transmission is between BRA and TUR ($g1_{1,5}$). According to ARCH parameters; cross-volatility spillovers in all markets are larger than the own-volatility spillovers and innovations of CHN influence the volatility of other markets. On the other hand, according to GARCH parameters, which indicate "volatility transmission" between CDS returns, the past volatility shocks have greater effect on the future volatilities between country pairs.

The conditional covariance graphs show the volatilities of all covariance between CDS returns are increased with the first signals of global crisis in the June 2006. Accordingly, it can be said that a shock in one countries CDS risk premium has strong information effects on other countries CDS risk premiums and strong volatility transmission is also seen. In September 2008, when the global crisis hit the world, the volatilities of covariance are seen mostly between RUS-SOA.

In global crisis period, China sustained its economic growth although a little decreases. Brazil's economy started to grow after two quarters of depression in the early global crisis session. Russia became one of the most affected country from the global crisis by the rapid decline in raw materials prices. The most affected countries are seen as Russia and Brazil.

The CDS market has become important in more recent years globally, especially for emerging countries where sovereign risk is an important indicator to foreign investors in assessing risks of their foreign direct investment and portfolio investments. In a well-functioning financial market, the CDS returns reflects the riskiness of the underlying event. China's economy has experienced remarkable structural and institutional changes in recent decades, particularly during the global crisis. For the past three decades, the China's economy has demonstrated impressive economic growth, and become the second largest economy in the world. As China has opened up to the world, it is likely that its economy has become more closely linked to global economic conditions.

The Brazil, Russia, China, South Africa and Turkey as emerging markets have become a lifeline for the global economy. As the story goes, these countries will continue to emerge, providing much-needed global growth and leadership. Emerging markets hit their full stride by 2000. China's economy is bigger than those of Brazil, Russia, Turkey and South Africa combined, and it continues to grow at a faster clip than any of them.

In Brazil and Turkey, inflationary episodes, coupled with a dependence on external debt, have frequently accompanied political instability. Both countries came through the international financial crisis relatively unscathed and returned rapidly to growth. Both have subsequently slowed, as the international environment has evolved.

A tidal wave of global liquidity, searching for high yielding economies (or, more precisely, economies which actually demonstrate growth potential) has added to concerns, whether perceived or real, of currency "wars" waged against emerging markets. Meanwhile, consumption slowdowns due to political and economic factors in some of Brazil and Turkey's major export markets have added to an environment where the moves of their respective central banks have been watched closely.

The last twelve months have seen increasing disparities in international perceptions of two of the world's most prominent emerging markets. Turkey has, until recently, been treated more with the approach of cave emptor – its inflationary history and current account deficit, combined with long memories of political instability, have acted as red flags for international investors.

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