International Review of Financial Analysis 39 (2015) 7–18

Contents lists available at ScienceDirect

International Review of Financial Analysis

Stock market volatility spillovers and portfolio hedging: BRICS and the financial crisis

Theodore Syriopoulos [a,b,*], Beljid Makram [c], Adel Boubaker [c]

[a] Department of Shipping, Trade and Transport, School of Business Studies, University of the Aegean, 2A Korai str., 82100 Chios, Greece
[b] Audencia Nantes School of Management, 8, Route de la Joneliere, BP 31222, 44312 Nantes, France
[c] Department of Finance and Accounting, University of Tunis El Manar, B.P. 248, C.P. 2092, Tunis Cedex, Tunisia

ARTICLE INFO

Article history:
Received 8 August 2014
Received in revised form 23 November 2014
Accepted 23 January 2015
Available online 3 February 2015

JEL classification:
C32
C58
F65
G11
G15

Keywords:
BRICS markets
Dynamic volatility spillovers
VAR(k)–GARCH(p,q) model
Hedge ratios
Optimal portfolio allocation

ABSTRACT

The paper investigates the dynamic risk–return properties of the BRICS (Brazil, Russia, India, China, South Africa) capital markets and models potential time-varying correlations and volatility spillover effects with the US stock market. A VAR(*1*)–GARCH(*1,1*) framework contributes useful insight into US–BRICS market interactions and expands on a thin past empirical literature. A disaggregated approach pays attention to critical US–BRICS business sectors, namely the industrial and financial sectors. Significant return and volatility transmission dynamics are identified between the US and BRICS stock markets and business sectors. This is a critical input that can affect efficient global portfolio diversification and risk management strategies. Based on this empirical evidence, the study proceeds to assess effective portfolio hedge ratios and to construct optimal portfolio weights for diversified asset allocation to US–BRICS markets and business sectors.

1. Introduction

Based on recent economic forecasts, Brazil, Russia, India, China and South Africa (BRICS) are anticipated to exhibit exceptionally high economic growth rates over the next 50 years. This will result to BRICS jointly growing larger than the G-6 in US dollar terms (Wilson & Purushothaman, 2003; Table 1). The BRICs acronym was coined by Jim O'Neill (2001), Goldman Sachs chief global economist, who emphasized on the spectacular economic growth prospects of BRICs. The BRICs cover 25% of the world's land mass, 40% of the world's population and run increasingly as global market economies (Frank & Frank, 2010). South Africa has more recently joined the BRIC economies to now form the BRICS group. The BRICS share in world GDP and global exports is expected to grow by 2015 from 14 to 21.6% and from 12.4 to 20.1%, respectively (at the same time, the US export share is anticipated to decline from 25 to 22%) (Wilson & Purushothaman, 2003). The sustainability of BRICS' impressive growth path is subject to further structural and institutional reforms and financial liberalization, foreign investment inflows and international competition (Aye et al., 2014; Bhar & Nikolova, 2009a; Carlos & Castro, 2011; Chkili & Nguyen, 2014; De Vries, Erumban, Timmer, Voskoboynikov, & Wu, 2012; Manamperi, 2014; Pradhan, Dasgupta, & Bele, 2013; Sarwar, 2012).

As global investors persistently pursue attractive asset classes to allocate their portfolios on alternative style investing, BRICS capital markets receive increasing international fund inflows (Cheng, Cutierrez, Mahajan, Shachmurove, & Shahrokhi, 2007; Ghosh, Havlik, Ribeiro, & Urban, 2009; Sledzik, 2012). Understanding the function of BRICS equity markets, their dynamic risk–return properties, potential volatility spillover effects, interrelationships and reactions to shocks, events or news, relative to leading global mature markets, such as the US equity market, remains a crucial issue for international investors, portfolio managers and policymakers. The recent global spillover and contagion effects, induced by the 2007–8 US subprime mortgage financial crisis, illustrate

* Corresponding author at: Department of Shipping, Trade and Transport, School of Business Studies, University of the Aegean, 2A Korai str., 82100 Chios, Greece. Tel.: +30 22710 35861; fax: +30 22710 35299.
E-mail addresses: tsiriop@aegean.gr (T. Syriopoulos), beljid@gmail.com (B. Makram), adelboubaker.fsegt@rnu.tn (A. Boubaker).

http://dx.doi.org/10.1016/j.irfa.2015.01.015
1057-5219/

Table 1
BRICS real GDP growth (%): 5-year period averages.
Source: Wilson and Purushothaman (2003).

Country	2010–2015	2015–2020	2020–2025	2025–2030	2030–2035	2035–2040	2040–2045	2045–2050
Brazil	4.1	3.8	3.7	3.8	3.9	3.8	3.6	3.4
Russia	3.8	3.4	3.4	3.5	3.1	2.6	2.2	1.9
India	5.9	5.7	5.7	5.9	6.1	6.0	5.6	5.2
China	5.9	5.0	4.6	4.1	3.9	3.9	3.5	2.9
South Africa	3.6	3.3	3.3	3.1	3.3	3.3	3.3	3.3

the high level of dynamic interactions between mature and emerging capital markets (Berger & Turtle, 2011). Short- and long-run stock market dynamics can have critical implications for asset valuation, portfolio allocation, efficient diversification, hedging, and risk control. If, for instance, return and volatility spillover effects are seen to spread from one market to another at times of market crashes, adverse events or financial crises, portfolio diversification benefits should be expected to remain limited. In this case, global investors would have to adjust their asset allocation decisions in order to mitigate contagion risks (Aloui, Aissa, & Nguyen, 2011; Celik, 2012; Kenourgios, Samitas, & Paltalidis, 2011; Syriopoulos, 2006, 2007, 2011, 2013; Syriopoulos & Roumpis, 2009).

Despite growing global attention on the BRICS capital markets, the relevant body of empirical research remains surprisingly limited and further insight would be useful. This study attempts to fill some of the gaps in the topic and contributes a range of innovative and fruitful empirical conclusions. Hence, the main purposes of this paper are: (a) to investigate the dynamic risk–return profile of BRICS stock markets from a portfolio management viewpoint, assuming a representative US-based portfolio manager; (b) to examine market reactions to shocks, volatility transmission and spillover effects between the US and BRICS stock markets; and, (c) to assess effective portfolio hedge ratios and construct optimal portfolio weights for diversified portfolios to US–BRICS markets and business sectors. The US market is incorporated as a representative leading mature, developed stock market with high liquidity, trading depth and global visibility. An innovative contribution of the study is that it follows a disaggregated approach, departing from past empirical practice that has conventionally focused on an aggregate global, regional or country stock market level (An, 2010; Bhar & Nikolova, 2009a, 2009b; Bianconi, Yoshino, & Machodo de Sousa, 2013; Hammoudeh, Sari, Uzunkaya, & Liu, 2013; Singh, Kumar, & Pandey, 2010; Xu & Hamori, 2012). On the contrary, the study pays empirical attention to important listed business sectors and focuses on the US and BRICS industrial and financial sectors. This approach contributes to a better understanding of the US–BRICS stock market dynamics and spillover effects and can support more efficiently the realistic asset pricing, volatility prediction, efficient cross-market allocation and hedging decisions and, ultimately, optimal portfolio management strategies.

A vector autoregressive (VAR)–generalized autoregressive conditional heteroskedasticity (GARCH) framework (VAR(k)–GARCH(p,q)) is employed, in order to empirically investigate these issues (Arouri, Jouini, & Nguyen, 2012; Ling & McAleer, 2003). A key model advantage is the flexibility to investigate conditional volatility dynamics, shock transmissions and volatility spillover effects between equity markets. This model specification also provides meaningful estimates of the unknown parameters at relative computational ease compared to several other multivariate specifications. Assuming that the dominant US capital market can exert a leading impact on global capital markets, the model can also depict dynamic US–BRICS stock market interactions induced by critical shocks, events or news.

The rest of the paper is organized as follows. Section 2 sets the modeling framework to study the US–BRICS stock market dynamics. Section 3 analyzes the relevant data input and produces estimates of key descriptive statistics. Section 4 critically evaluates the empirical findings on the basis of a specified VAR(*1*)–GARCH(*1,1*) model. Section 5 discusses important financial implications for the formation of efficient hedging strategies that can support the construction of optimal portfolio allocations. Finally, Section 6 concludes.

2. Modeling US–BRICS stock market dynamics

Information flow across capital markets through the volatility-channel (correlation in second moments) has been argued to be more significant and visible compared to that of the returns-channel (correlation in first moment). Hence, understanding volatility properties and dynamics can be a better information-flow proxy for the underlying stock markets (Ross, 1989; Tauchen & Pitts, 1983). The GARCH framework, initially developed by Engle (1982, 2002) and generalized subsequently by Bollerslev (1986, 1990), has been established as a most convenient model structure to study dynamic return–risk properties and interactions between capital markets. Multivariate GARCH (MGARCH) specifications with constant or dynamic conditional correlation and covariance matrices, such as the BEKK (full parameterization), CCC (constant conditional correlation) or DCC (dynamic conditional correlation) models, have been shown to be flexible and efficient in studying time-varying correlations and volatility spillover effects at the expense of univariate models (Baba, Engle, Kraft, & Kroner, 1989; Bollerslev, 1986, 1990; Engle, 2002; Engle & Kroner, 1995; Engle & Ng, 1993; Kroner & Ng, 1998; Tse & Tsui, 2002). However, the complex estimation procedures required can be a constraint for the implementation of these dynamic models, especially when a large number of variables are included (McAleer, 2005). Another issue of concern relates to model limitations to clearly depict meaningful cross-market volatility spillover effects, in a background of increasing financial market integration and globalization.

2.1. A disaggregated VAR(k)–GARCH(p,q) model

This paper employs a bivariate VAR(k)–GARCH(p,q) model to study jointly conditional returns and time-varying (conditional) volatilities and correlations as well as potential market shocks and spillover effects (k, p, q refer to number of lags in the VAR model, ARCH and GARCH effects, respectively). A disaggregated approach is incorporated in order to model different US and BRICS business sectors simultaneously in the stock markets under study, namely the industrial and financial sectors (Arouri et al., 2012; Hammoudeh, Yuan, & McAleer, 2009; Ling & McAleer, 2003; Mensi, Makram, Boubaker, & Managi, 2013). The VAR(k)–GARCH(p,q) models jointly (as a system) the mean and variance equations of each market/sector pair under study. In particular, the multivariate CCC–GARCH structure is employed, with correlations between system shocks assumed to be constant (Bollerslev, 1986, 1990; Engle, 2002; McAleer, Chan, Hoti, & Lieberman, 2008). Despite certain CCC–GARCH restrictive properties (constant correlation coefficients against shifting market conditions and/or investors' expectations), this model form is convenient for easing complex estimation and inference procedures at a disaggregated market level.

The VAR(*1*)–GARCH(*1,1*) specification is chosen on the basis of a two-step procedure to select the optimal lag structure (according to