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Cross-correlations between volatility, volatility persistence and stock market integration: the case of emergent stock markets

Alexandru Todea*

Department of Finance, Faculty of Economics and Business Administration, Babes-Bolyai University, 58-60, Teodor Mihali St, 400591 Cluj-Napoca, Romania

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ABSTRACT

In this paper, we investigate the dynamics of the two pairs of relationship, respectively volatility/market integration and volatility persistence/market integration, in the case of 20 emerging stock markets during the period 1999–2013. Employing the rolling windows approach we find that on most markets the persistent positive trend in volatility and volatility persistence is associated with the same trend in market integration. We use the detrending moving-average cross-correlation coefficients and we find positive cross-correlation that appears particularly in the long term and can only partly be attributed to the global financial crisis. The cross-section analysis shows that the markets which are more integrated display stronger volatility and volatility persistence, especially after 2005, when the level of market integration is higher. Our findings have several important implications for international portfolio management and security valuation.

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1. Introduction

Financial markets are complex systems with interacting heterogeneous agents and naturally most of the processes that characterize them could be on the edge of stationarity or non-stationarity. Moreover, non-stationarity is particularly pronounced in periods of crisis, when investors' expectations and the business relations between companies are changing [1,2]. Exploring cross-correlations between non-stationary time series has become a popular topic in the last decade. Thus, several time domain estimators of the power-law cross-correlations have been proposed – detrended cross-correlations analysis [3], detrending moving average cross-correlation analysis [4,5], the height cross-correlation analysis [6] and rescaled covariance test [7]. An attractive alternative is the frequency domain estimators also [8,9] due to their high performance in the presence of heavy tails distributions [10].

These methods have been extensively used in the investigation of several topics in finance. It may be mentioned cross-correlations analysis between: different stock markets [11], oil and exchange markets [12], oil and stock markets [13] spot and futures markets [14], price and volume [15] or efficiency and multifractality [16,17]. However, a rich literature is focused on investigating connections between volatility and other financial variables, due to its importance in financial economics and its power-law nature. Thus, the tendency of past returns to be negatively correlated with future volatility was first noted by Black [18]. Known as the 'leverage effect', this relation was studied using various power-law cross-correlations estimators [7,19,20]. Other analyzed relations are volatility-trading volumes [21], volatility-liquidity [22] or volatility-Google searches [23].

In financial economics, volatility is a proxy for investment risk and its prediction accuracy plays a crucial role in security valuation, financial risk management and trading strategies [24]. The long-range time correlation of volatilities or "volatility clustering" is one of the most famous stylized fact of the financial dynamics widely investigated since the 80 s[25]. In this case, the autocorrelations of absolute and squared returns of time series decay slowly and volatility exhibits a long memory property. Additionally, when returns process exhibit persistence in volatility, an additional source of risk emerges for investors [26]. Long term volatility of macroeconomic fundamentals is considered the main cause of this phenomenon [27,28], while other determinants are the level of development and the size of the markets [29]. At the same time, many studies point out that structural breaks may induce spurious long memory effects [30,31]. Recent approaches support the possibility of long memory and structural breaks co-existence, in which case the degree of persistence may vary over time [32,33].

* Tel.: +40 264 41 86 52; fax: +40 264 41 25 70.
E-mail address: alexandru.todea@econ.ubbcluj.ro

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In the last decades, the emerging stock markets have experienced an increase in their degree of integration with the world market due to the ongoing financial liberalization and economic openness processes. The positive macroeconomic implications of stock market integration are reflected in higher economic growth [34], increased foreign investments [35] and decreased cost of capital [36]. At investors' level, increasing integration of emerging markets leads to reducing the potential of risk diversification. However, their incomplete integration into world markets enables the treatment of these markets as distinct asset classes and this has important policy implications for financial investment management [37]. The risk of an international diversified portfolio depends on the correlations between markets, but also depends on the specific risk of each market. Therefore, it would be interesting to study how volatility and persistence in volatility are connected with the integration degree of emerging markets with the global market.

In this study, we investigate the cross-correlation between volatility/volatility persistence and stock markets integration for 20 emerging markets during 1999–2013. To measure volatility we use classical standard deviation of returns and to explore the long memory property in unconditional volatility we opted for the two-step exact local Whittle (2ELW)[1] estimator proposed by Shimotsu [38]. This is robust to misspecification of the short-run memory of the process and provides a long memory estimator suitable for financial data by allowing for unknown mean and polynomial time trend. Market integration is measured by R-squared proposed by Pukthuanthong and Roll [39]. This direct measure represents the proportion of a number of global factors which explain the variation in the returns of an emergent stock market index. In order to capture the dynamics of the two phenomena we determine the two measures using a rolling windows approach. Since the series obtained this way are on the edge of stationarity or non-stationarity, studying the relation between them requires efficient estimators of correlation. In this study, we use the detrending moving-average cross-correlation analysis (DMCA) [4,5].

The main motivation for this study, is that we can formulate opposing hypotheses regarding the nature of the relation of the two pairs of series, respectively volatility/integration and persistence in volatility/integration. An indirect correlation between volatility and integration could be supported by the theoretical model proposed by Evans and Hnatkovska [40]. On the other hand, the more integrated the markets become, the more their volatility will retrieve from the volatility of global factors leading to a direct correlation. It is expected that during a global crisis such a relation to manifest itself with greater intensity. As regarding the relation persistence in volatility/integration, an indirect correlation could be supported by the hypothesis that a high degree of integration should lead to a reduction of stock market long memory. An integrated market responds better to global factors due to the presence of foreign investors. They have a superior ability to incorporate global information into stock prices [41] and their arbitrage operations will determine a decrease in long memory. The indirect correlation could also be supported by the fact that persistence is highly related to volatility, namely in periods of high volatility the persistence phenomenon is more pronounced. A direct correlation could be sustained by the fact that the markets more integrated respond better to global factors. Global and macroeconomic announcements can induce volatility persistence [42] due to the contemporaneous aggregation of weakly dependent information flow processes [43]. A further explanation is based on the interaction between different agents with different time horizons [44]. The diversity of these agents is directly proportional to the degree of integration of emerging stock markets and could result in increased volatility persistence.

The second motivation is based on the fact that these relations have not been studied before using a direct measure of stock market integration. Financial liberalization is a necessary but not a sufficient condition for markets to become integrated with the global market. The level of integration also depends on other indirect barriers which discourage foreign investments, such as investor protection, the availability of information, differential accounting standards, country risk, and underdevelopment of the institutional environment [45].

This study aims to answer several questions: (1) What is the nature of the correlation between volatility/volatility persistence and stock markets integration? (2) Does correlation manifest itself more strongly in the short term or in the long term? (3) Does the global financial crisis influence the results? (4) What kind of association exists in cross-section between market integration and volatility/volatility persistence?

The remainder of the paper is organized as follows: Section 2 presents the data and the methodology used in this study. Section 3 reports the empirical analysis and its results, and Section 4 concludes.

2. The data and methodology

2.1. The data

The sample consists of the daily closing values of the stock market indexes of 20 emerging markets and 21 developed markets. The data for the developed markets is necessary in order to build the integration measure for the emerging stock markets. Denominated in dollar, the daily data for stock market indexes is extracted from DataStream, a division of Thomson Financial. The data, which are perfectly synchronized after extraction from the database, were cleansed of a few trading sessions each year. The trading sessions in which the vast majority of the markets showed no variation of the index on account of holidays or New Year's Eve were removed. Thus, in the case of emerging markets, the data spans from January 1999 to December 2013, totaling 3901 observations, while for the developed markets the data ranges from January 1998 to December 2013, totaling 4134 observations. For developed markets, the data from 1998 are necessary to build the 1999 global factor series. We compute daily compounded return for day t, as $\ln(P_t) - \ln(P_{t-1})$, where P_t is closing value of day t.

Table 1 presents the sample of emerging stock markets, the related market indexes, and the descriptive statistics of the return series. It is found from Jarque–Bera statistics that the assumption that all returns distributions are Gaussian is rejected at the 1% significance level. The skewness different from zero (majority are left-skewed) and kurtosis more than three suggest that returns distributions have fat tail features.

2.2. Measuring volatility persistence and stock market integration

To capture the dynamic of volatility, volatility persistence and market integration, we estimate standard deviation of returns (σ), fractional integration parameter (d) and integration measure (R^2) in rolling windows. We choose a window of 512 observations (about two years), thus ensuring a compromise on the amount of data required for measuring the persistence volatility and stock markets integration. The volatility persistence is observable over longer periods of time, the existing studies [46,47] using windows of 4 years. At the same time, market integration is rather a state of market against the world market at some point in time, reason for which the estimation period of R^2 is one year [39,48,49].

[1] The Matlab code is available at http://qed.econ.queensu.ca/faculty/shimotsu/programs/elwcode.zip; the code was adapted for the rolling window approach.

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