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## Spillover effects of the 2008 global financial crisis on the volatility of the Indian equity markets: Coupling or uncoupling? A study on sector-based data

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## ABSTRACT

This paper focuses on the following question: has the global financial stress in the US markets during the subprime crisis induced a persistent volatility of Indian equity stocks? We answer this question using sector-based data and we propose a simple stochastic volatility model augmented with exogenous inputs (financial stress indicators in the US market). We derive analytically the autocorrelation of the squared returns using cross-moments and estimate the impact of several variables such as the CDS spreads, the ABCP spreads, market liquidity, the volatility of the S&P 500 using a Kalman filter approach with the impact captured through Almon polynomials. We find a strong evidence of persistent volatility irrespective of the sector and interpret this finding as the result of two factors: the lower liquidity of the Indian equity markets during the subprime crisis and a wake-up call effect.

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## 1. Introduction

During the 2008 global financial crisis, the volatility of the Indian equity returns has been characterized by huge variations. In this paper we want to examine whether the move from low volatility episodes to higher volatility episodes was triggered by the financial stress in the US financial markets. The case of the Indian markets deserves a special attention for the following reason. While the association between the global financial turmoil and the increased volatility of the Asian markets seems to be widely recognized, the hypothesis of financial uncoupling has dominated in India. In the policy circles, it has been argued that, compared with its peers in the rest of Asia, the Indian financial and banking sectors have been immune and insulated from the global financial crisis. This is in sharp contrast with what one observed during the former 1997 Asian crisis when the epicenter of the crisis was regional. The reasons why the Indian equity markets have been capable of being immune against the global shock were thought to be the result of a confluence of diverse factors:

a minimal exposure to the toxic products issued in the US, limited off-balance sheet operations, the embryonic stage of the credit derivatives markets, regulatory restrictions on investment in toxic assets by residents, buoyant foreign reserves, and changes in prudential norms imposed by the Reserve Bank of India. These factors would explain why the fall of stock markets on a negative sentiment was limited. Such a view was echoed in a recent paper by Bekaert et al. (2011) who use an international CAPM model on sector-based data from 55 developed and emerging countries (including India) and conclude that the international contagion during the subprime crisis played little role to explain the observed changes in the equity returns but the domestic factors (economic fundamentals and institutions) were the predominant factors.

As a criticism to this view, one can argue that the hypothesis of a resilience of the Indian stock markets to the US subprime crisis does not accord with an academic empirical literature (although the papers are still rare) suggesting an integration of the Indian stock markets with global markets, just as is the case for the other Asian countries (see, for instance, Raj and Dhal (2008)). Further, the profitability performance of the companies is likely to have suffered from the repatriation by the US institutional investors of the funds they had invested in the Indian economic and financial sectors in order to reduce their losses in the US financial markets, from credit constraints on bearish domestic capital markets, and from the decline

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in internal accruals of corporate. Whether or not these factors were the sources of the surge in volatility observed in the equity markets is still an open question.

The concept of financial coupling or uncoupling remains controversial. Several approaches exist in the literature: contagion, interdependence, and co-movements between the returns. Here, we retain the following simple definition. We say that during the subprime crisis the Indian equity markets were financially coupled with the US or global markets if there was a significant and persistent causal impact of the latter on the former. The transmission channels could have played from the global financial sector to the equity returns or to their volatility. In the sequel, we focus on the volatility. The existing literature is devoted, in great part, to examining the transmission channels among mature markets (e.g. Corsetti, Pericoli, & Sbracia, 2005; Kaminsky, Reinhart, & Vegh, 2003; King et al., 1994). However, papers examining the transmission of shocks from mature to emerging markets are few. For instance, Dufrénot, Mignon, and Péguin-Feissolle (2011) have shown that the financial stress in the US markets, during the subprime crisis, is transmitted to the LAC's stock market volatility, especially in Mexico. Gimet (2011) have pointed out that the impact of the recent subprime crisis on emerging ASEAN countries is less significant than that observed in industrialized ones. Financial spillovers from the US markets to emerging markets have also been highlighted by Frank, Gonzalez-Hermosillo, and Hesse (2008), Frank and Hesse (2009), Berglöf, Korniyenko, Plekhanov, and Zettelmeyer (2010) and Rose and Spiegel (2010). Our paper is a further contribution to this recent literature but focuses on India, one of the biggest emerging countries in the world.

According to us, the important question is not whether or not the subprime crisis impacted the volatility of the Indian equity markets. One would be surprised if the answer was no. The interesting issue is whether this impact has been significant and persistent. On one side, the answer could be negative and one may argue that the initial shock was virulent but short lived. In this sense, a financial uncoupling would not mean that the volatility was insensitive to changes in the US financial market conditions, but that the global financial crisis exerted a very transitory and small effect on the Indian equity stock volatility with a rapid feedback to the average volatility level observed during calm periods. Among the factors that could bar any persistent effects are the policies undertaken in order to prevent the equity and financial markets from becoming too volatile and turbulent, in particular the monetary response by the Reserve Bank (reduction of the repo rate and cash reserve ratio, a more stringent implementation of Basel II requirements, nonconventional measures such as the creation of refinance facilities without collaterals, etc.) and the launch of recovery plans. The prompt reaction of both the government and monetary authorities may have contributed to ensure confidence of the financial markets and dampen the spread of the global shock in the Indian equity markets. On the other side, a persistent impact of the US financial shock on the volatility, reflecting a great exposure of the investors to risk, could be explained by different elements implying that a shock from the global markets takes time before being completely absorbed by the Indian stock markets: contagion effects implying volatility spillovers across markets, fly to quality, the dependence of some sectors to external commercial borrowings, the impact of the financial crisis on the real sector inducing a deceleration of profits, and the fact that domestic saving and investment in India have a low correlation thereby implying that the investment rate is driven by foreign saving, etc.

Thus, our paper focuses on the following question: has the global financial stress in the US markets during the subprime crisis induced a persistent volatility of Indian equity stocks? This question still needs to be answered for three reasons. Firstly, the international investors overwhelm the Indian equity markets and their actions enhance the stock price volatility because the markets are small and have low liquidity. During a global financial crisis, the volatility is exacerbated,

either because the investors enter the markets in search of higher returns in comparison with what they are offered in the industrialized equity markets, or because they sell off the Indian assets. Secondly, it is likely that the financial crisis stemming from the US markets acted as a carrier of a volatility contagion from the Asian markets to the Indian equity markets. Indeed, even if the Indian markets were not directly financially coupled with the US and European markets, they could still be affected by the global crisis once the other Asian markets would be hit. Indeed the Indian markets are highly integrated with the latter and the effects would therefore be indirect. Thirdly, the question as to whether the openness to foreign financial markets dampened or increased the equity price volatility during the crisis has led to two different viewpoints in the Indian policy circles. Some people say that the observed volatility in the equity prices would have been much higher in the absence of openness to foreign capital because foreign participation in domestic financial markets increases market size and liquidity which in turn reduces volatility. Others argue that things happened the other way around. The observed surge during the subprime crisis occurred because the Indian stock markets have been more vulnerable to contagion effects from other markets. Providing empirical evidence of a persistent (or a non-persistent) volatility caused by the US markets would be an argument against (or in favor) of the second viewpoint.

To answer the above question, our contribution to the literature is empirical. We investigate volatility clustering by proposing an ARSVX model (autoregressive stochastic volatility model with exogenous inputs) in order to see whether any long range dependence in the second moments of the returns can be explained by capitalizing on the information contained in the variables reflecting the global financial crisis. This makes a difference with the previous literature. Indeed, previous empirical works studying the impact of past financial crises on the Indian and East Asian stock markets relied on methodologies which include GARCH models, cointegration systems, multiplicative error models, VAR models, and copulas (see Aloui, Aissa, and Nguyen (2011), Wong, Agarwal, and Du (2005), Beirne, Caporale, Schulze-Ghattas, and Spagnolo (2010), Gallo and Velucchi (2009), Ghosh, Saidi, and Johnson (1999), Kumar and Mukhopadhyay (2007), Mukherjee and Mishra (2008), Raj and Dhal (2008)). These models have however been criticized for their lack of theoretical foundations. Conversely, the stochastic volatility model can be derived from theoretical equity price models in the finance literature. Further, their advantage over GARCH models is to provide a more realistic correlation structure of the squared returns since GARCH specifications have been found to amplify the volatility dynamics present in the data when compared with the stochastic volatility models. Our goal is, however, more modest than Bekaert et al. (2011) paper since we do not aim to discriminate between different types of causal effects (global shocks, sector-specific shocks, country-specific shocks).

Our model also differs from the widely used stochastic volatility model in several aspects. The modeling of financial time series using autoregressive stochastic volatility (ARSV) models has received much attention in the literature. However, the case where the transition equation is augmented with explanatory variables, other than a constant and a deterministic trend, though frequently evoked as a possible extension of the standard specification, has been rarely applied in practice. Most of the time, additional explanatory variables are included in the signal equation. Adding them in the state equation has two implications for our purpose. Firstly, we derive the analytical expressions of the second-order moments and of the autocorrelation function of the squared returns conditional on the exogenous inputs. We show that, in addition to the persistence of the latent variable (which captures the sources of volatility other than the volatility caused by the global financial crisis), the persistence in the volatility of returns also comes from the length of time taken by the Indian markets to absorb the foreign shocks and from the magnitude of the changes in the US financial stress indicators (their mean and

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