Economic Modelling 45 (2015) 223–235

Contents lists available at ScienceDirect

Economic Modelling

journal homepage: www.elsevier.com/locate/ecmod

A range-based volatility approach to measuring volatility contagion in securitized real estate markets

Randy I. Anderson [a], Yi-Chi Chen [b,*], Li-Min Wang [c]

[a] Griffin Capital Corporation, El Segundo, CA 90245, USA
[b] Department of Economics, National Cheng Kung University, Tainan 701, Taiwan
[c] Bank SinoPac, Taipei 104, Taiwan

ARTICLE INFO

Article history:
Accepted 28 October 2014
Available online 24 December 2014

Keywords:
Price range
CARR
Financial crisis
Smooth transition copula
Volatility contagion
REIT

ABSTRACT

We use a newly-developed time-varying range-based volatility model to capture the dynamics of securitized real estate volatility. The novelty of the model is the use of a smooth transition copula function to capture the nonlinear comovements between major REIT markets in the presence of structural changes. We then investigate the impact of extreme events on the volatility dependence in a broad set of 13 developed countries over the period from 1990 to 2012. We find that information transmission through the volatility channel can exhibit either bi- or uni-directional causality. In addition, financial contagion following the subprime crisis is found between the U.S. and Australia.

1. Introduction

The benefits of diversification, especially between multiple asset classes with varying degrees of correlation, have long been a widely accepted by finance practitioners and academics. However, recent experience during the market crises of the late 2000s has shown that diversification may not always produce the benefits promised. Therefore, a better understanding of the dynamics of the correlation between asset markets is important for asset pricing, portfolio allocation, and risk management.

For example, the comovement between asset returns is likely to change over time, thus creating a need to dynamically update portfolio allocations to improve investment strategies. However, the cross-market linkage is not necessarily through the return channel, as volatility may always link markets. In particular, the literature has found that the spreading of shocks from one market to another can cause markets to be highly correlated after a financial crisis, a phenomenon known as financial contagion (Forbes and Rigobon, 2002).

In this paper we investigate volatility contagion in REIT markets. While previous studies generally focus on asset returns, we examine financial contagion in depth from the volatility perspective. In particular, we employ the price range of REITs as a measure of volatility in this study. This range, defined as the difference between the highest and lowest asset price over a fixed time interval, has long been used as a proxy for volatility in finance. In contrast to return-based volatility, this range is more efficient and more informative regarding future volatility, as well as being more robust to market microstructure noise (Alizadeh et al., 2002; Brandt and Diebold, 2006; Chou, 2005; Parkinson, 1980).

An obvious advantage of the price range is that for many financial assets it incorporates more information on price movements within a fixed period of trading time, whereas the squared or absolute return only includes two data points of closing prices. This is a particularly striking feature when the market experiences large swings. While the application of the price range as a volatility proxy has been increasingly popular in the general finance literature, it still remains unexplored in the real estate literature. Furthermore, it has been argued that market linkages may change after a financial crisis, and volatility is considered as an important channel for this. Several studies on the transmission of volatility, e.g., Engle and Susmel (1993); Cheung and Ng (1996); Diebold and Yilmaz (2009), have produced substantial empirical evidence regarding volatility spillovers, and suggest that financial contagion should be examined in depth from the volatility perspective.

This paper also deals with some of the econometric aspects of the international volatility transmission mechanism, and focuses on some

* Corresponding author. Tel.: +886 6 275 7575#50228; fax: +886 6 276 6491.
E-mail addresses: randerson@griffincapital.com (R.I. Anderson), yichi@ncku.edu.tw (Y.-C. Chen), wanglm06@gmail.com (L.-M. Wang).

http://dx.doi.org/10.1016/j.econmod.2014.10.058
0264-9993/

nonlinear and asymmetric aspects of the relationships among markets. The need for such an approach is seen in several theoretical papers that consider various possible transmission mechanisms for shocks, such as trade and the integration of financial markets.[1]

Given the significant impact of financial crises on market linkages, we use the range-based volatility model introduced by Chiang and Wang (2011) to test for a change in the volatility dependence structure. The model extends the conditional autoregressive range (CARR) model proposed by Chou (2005) to the time-varying logarithmic CARR (TVLCARR) model, which is characterized by the state variable within a smooth transition function to reflect the time-dependent structure of volatility dependence. Smooth transition models are suitable for modeling financial markets, as a number of factors, such as the large number of investors, different investment horizons and varying learning speeds, can lead to smooth rather than discrete adjustments. To further examine whether financial contagion occurs across different countries in response to a specific financial crisis, a smooth transition copula and a corresponding test against the time-varying copula are performed. The assumption of smooth transition between states allows for a generalization of Forbes and Rigobon's (2002) definition of contagion, in the sense that it also allows for contagion to occur smoothly. In this context, contagion is implied by a significant increase in the copula parameters after a crisis. Therefore, a smooth transition copula with the marginal distributions derived from the TVLCARR model is adopted in order to analyze the contagion of financial volatility across REIT markets.

To the best of our knowledge, Hoesli and Reka (2013) is the only other study that has analyzed financial contagion in REIT markets. Based on the multivariate GARCH model, the previous authors examined the different aspects of the cross-market comovement for the U.S., the U.K. and Australia, including volatility spillovers, tail dependence, and financial contagion.

Despite its pioneering efforts, our study complements the existing literature in several ways. First, we directly characterize the dynamics of the underlying volatility process with a range-based volatility measure, instead of the squared asset returns, as the price range approach can lead to greater estimation efficiency. Second, the smooth transition conditional autoregressive range model allows for structural changes in dynamic volatility. In sharp contrast to the sudden change introduced in Hoesli and Reka (2013), we allow for smooth transitions in the range-based volatility process. Further, the structural shift in the volatility dependence process is examined, instead of the return correlation switch that was investigated in past research. The literature on financial contagion, particularly for REIT markets, has not yet directly examined the issue from a volatility perspective, even though this is a factor of considerable interest. Third, the possible nonlinear volatility dependence and the occurrence of structural changes in this during situations of extreme volatility are examined across 13 major countries covering different regions of the world, which allows for better understanding of the dynamic linkages and interdependencies across international REIT markets.

The remainder of this paper is organized as follows. Section 2 summarizes the previous work on market linkages with a focus on securitized real estate markets. Section 3 describes the TVLCARR model and the smooth transition copula function used in this work. Section 4 presents our empirical analysis with respect to the behavior of REIT volatility and the nonlinear cross-market association in volatility dependence. The final section then provides the conclusions of this study.

[1] See Forbes and Rigobon (2002) and references therein for a survey of international transmission mechanisms in financial markets.

2. Literature review

Although it is accepted that asset returns are generally not normal, a joint multivariate normal distribution might lead to a misleading description of asset dependence. A number of studies (Ang and Chen, 2002; Longin and Solnik, 2001) have noted that asymmetric correlations are observed between equity returns, as they tend to be more correlated during bear than bull periods. Hartmann et al. (2004) found that as the global economies become closely connected, a crash in one equity market is quickly passed on to others. This asymmetric dependence is not unique in equities, and can be observed in other assets, such as exchange rates (Patton, 2006), government bonds (Kumar and Okimoto, 2011) and real estate (Goorah, 2007). In particular, Embrechts et al. (2002) pointed out that under extreme events, such as the Asian financial crisis of 1997 and the U.S. subprime mortgage crisis of 2007, the comovement of asset returns behave differently from those in normal periods, and one should focus on the measures of tail dependence. Therefore, well-performed asset allocation or hedging strategies may be inadequate, at least to the extent that a symmetric normal distribution cannot completely characterize the dependence structure of asset returns.

While the analysis of extreme risks and tail dependence have often been studied for stock markets (see, e.g., Poon et al, 2004), little work exists relating to real estate, although there are a number of notable exceptions. Zhou and Anderson (2012) found that the extreme risks, as measured by value-at-risk (VaR) and expected shortfall, of REITs are generally higher than those of equities, and have increased significantly in the recent global financial crisis. Applications of copulas have also received increasing attention in modeling the nonlinear dependence structure of real estate markets. For example, Zhou and Gao (2012) found that the flexible symmetrized Joe–Clayton (SJC) copula can well capture the different strengths and dynamics of tail dependence in real estate securities markets. Hoesli and Reka (2013) tested for possible structural changes in tail dependences using the SJC copula, and found significant evidence of market contagion between the U.S. and the U.K. following the subprime crisis.

Cross-market linkages in REIT markets can be established through the transmission of shocks or volatility. For example, Liow and Newell (2012) observed volatility causality in REITs between many Asian countries and the U.S. Liow et al. (2009) documented a time-varying conditional correlation structure between real estate markets, and market correlations are positively correlated with changes in conditional volatility over time. Michayluk et al. (2006) found that there exists an asymmetric effect on both the volatilities and the correlations between the U.S. and U.K. securitized real estate markets. In sum, the existing literature has recognized the importance of volatility transmission and nonlinear comovement between markets.

3. The model

The TVLCARR model, proposed by Chiang and Wang (2011), is used to investigate the volatility dynamics in real estate markets. The merit of the TVLCARR model lies in its possibility of capturing a possible structural change in volatility series, and it is thus more flexible than the original CARR model proposed in Chou (2005). The TVLCARR(p,q) model is defined as follows:

$$R_t = \xi_t \varepsilon_t, \qquad \xi_t = \exp(\lambda_t), \tag{1}$$

$$\lambda_t = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i} + \sum_{j=1}^{q} \beta_j \lambda_{t-j} + \left(\omega^* + \sum_{i=1}^{p} \alpha_i^* \varepsilon_{t-i} + \sum_{j=1}^{q} \beta_j^* \lambda_{t-j} \right) \cdot \overline{G}(s_t; \gamma, c), \tag{2}$$