Finance Research Letters 15 (2015) 49–58

Contents lists available at ScienceDirect

Finance Research Letters

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

Granger causality and systemic risk

Marina Balboa[a], Germán López-Espinosa[b], Antonio Rubia[a,*]

[a] University of Alicante, Spain
[b] University of Navarra, Spain

ARTICLE INFO

Article history:
Received 17 June 2015
Accepted 8 August 2015
Available online 14 August 2015

JEL classification:
C32
G01
G15
G21

Keywords:
Interconnection
Spillover
Financial contagion

ABSTRACT

Building on the concept of Granger causality in risk in Hong et al. (2009), and focusing on an international sample of large-capitalization banks, we test for predictability in comovements in the left tails of returns of individual banks and the global system. The main results show that large individual shocks (defined as balance-sheet contractions exceeding the 1% VaR level) are a strong predictor of subsequent shocks in the global system. This evidence is particularly strong for US banks with large desks of proprietary trading. Similarly, we document strong evidence of financial vulnerabilities (exposures) to systemic shocks in US subprime creditors.

1. Introduction

The global financial crisis has motivated a growing interest on identifying the channels of systemic contagion. Granger causality, one of the key concepts in modern Economics, provides a powerful testing principle to address systemic interdependence. Surprisingly, this issue has received little attention in this field. Building on the notion of Granger causality in risk proposed by Hong et al. (2009), in this paper we address bilateral Granger-causal relationships that interconnect large losses of international large-capitalization banks with losses in the financial system. The main aim is to robustly address the existence of tail comovements featuring financial contagion in the global banking industry without relying on explicit assumptions about the formally unknown distribution of returns.

* Corresponding author at: Department of Financial Economics, University of Alicante, CP 03080 Alicante, Spain. Tel./fax: +34 965 90 34 00.
E-mail address: antonio.rubia@ua.es (A. Rubia).

http://dx.doi.org/10.1016/j.frl.2015.08.003
1544-6123/

The semiparametric testing procedure in Hong et al. (2009) (HLW henceforth) presents important methodological advantages over alternative methods in terms of robustness and generality. The CoVaR model in Adrian and Brunnermeier (2011) determines how the distress of a bank (characterized by its VaR) spills over the total system using quantile regressions. Conditioning *at* the VaR, however, is restrictive and gives rise to certain caveats; see Mainik and Schaanning (2014). Girardi and Ergün (2013) propose a more meaningful variant in which the conditioning event is given by VaR violations. This approach, however, requires explicit assumptions on the distribution of returns which may lead to biased estimates under misspecification. The HLW test builds on the same risk event as in Girardi and Ergün (2013) but needs not make strong assumptions on the underlying distribution, thereby ensuring robustness. Similarly, Billio et al. (2012) consider a non-linear measure of Granger causality that captures tail comovements via volatility spillovers. This approach requires maximum-likelihood estimates of a bivariate regime-switching model. The HLW test presents the comparative advantages of simplicity and, more importantly, generality, since Granger causality in risk can capture comovements not only in the conditional mean and/or volatility, but also in higher-order moments such as conditional skewness or kurtosis.

We consider weekly returns of 51 international large-capitalization banks in 18 advanced economies over the period July 2001 through December 2014, a period of major relevance for systemic risk. Consistent with previous evidence, the main results of our analysis show the existence of strong tail-interconnections under adverse market circumstances; see, for instance, Alemany et al. (2015) for a recent analysis. In particular, the occurrence of a stress event in a large-scale bank, characterized by a 1% VaR violation, is a reliable predictor of subsequent losses in the global system. The evidence of this class of predictability is stronger for the largest investment banks in the US. Remarkably, and consistent with the empirical observation that financial comovements are magnified during stressed conditions, tail predictability weakens under less extreme events. Finally, the analysis of Granger-causality in risk from the system to large-capitalization banks reveals sheer vulnerabilities in all the banks analyzed, this evidence being stronger for large US lending banks overexposed to the housing market and subprime-type lending activities.

The remaining of the paper is organized as follows. Section 2 introduces the notion of Granger-causality in risk and lays out the HLW testing procedure. Section 3 comments the main features of the data and the evidence of Granger causality in the tails. Finally, Section 4 summarizes and concludes.

2. Testing Granger causality in tails

2.1. Granger causality in risk

Let $\{r_{1t}\}$ and $\{r_{2t}\}$, $t = 1,\ldots,T$, be representative returns, with $\mathcal{F}_{jt} := \sigma\{r_{js} : s \leq t\}$, and $\mathcal{F}_t := \sigma\{r_s : s \leq t\}$, denoting the individual and overall sets of measurable information up to time t based on r_{jt}, $j \in \{1,2\}$, and $r_t := (r_{1t}, r_{2t})'$, respectively. Let $V_{jt}(\alpha), \alpha \in (0,1)$, be the $100\alpha\%$ Value-at-Risk (VaR) of $\{r_{jt}\}$ over a single-period horizon. Then, if:

$$\mathcal{H}_0 : \Pr(r_{2t} \leq -V_{2t}(\alpha)|\mathcal{F}_{2t-1}) = \Pr(r_{2t} \leq -V_{2t}(\alpha)|\mathcal{F}_{t-1}) := \alpha \tag{1}$$

holds true, according to HLW, r_{1t} is said *not to Granger-cause* r_{2t} *in risk at level* α *with respect to* $\mathcal{F}_{t-1}$. Intuitively, $\{r_{1t}\}$ does not carry out information to forecast the conditional α-quantile of r_{2t}. If, on the contrary,

$$\mathcal{H}_1 : \Pr(r_{2t} \leq -V_{2t}(\alpha)|\mathcal{F}_{2t-1}) \neq \Pr(r_{2t} \leq -V_{2t}(\alpha)|\mathcal{F}_{t-1}) \tag{2}$$

then we say that r_{1t} *Granger-causes* r_{2t} *in risk at level* α *with respect to* $\mathcal{F}_{t-1}$, and a VaR exceedance in r_{1t} is useful to predict future VaR exceedances in r_{2t}.