Int. Fin. Markets, Inst. and Money xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Journal of International Financial Markets, Institutions & Money

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

Systemic risk among European banks: A copula approach☆

Jacob Kleinow[a], Fernando Moreira[b,*]

[a] Department of Finance, Freiberg University, Freiberg D-09599, Germany
[b] Lecturer in Business Economics, Business School, University of Edinburgh, 29 Buccleuch Place, Edinburgh EH8 9JS, UK

ARTICLE INFO

Article history:
Received 21 October 2014
Accepted 10 January 2016
Available online xxx

Keywords:
SIFI
Copula
Interconnectedness
Bailout
Default
CDS
Europe
Contagion

JEL classification:
G21
G28
G33

ABSTRACT

This paper investigates the drivers of systemic risk and contagion among European banks. First, we use copulas to estimate the systemic risk contribution and systemic risk sensitivity based on CDS spreads of European banks from 2005 to 2014. We then run panel regressions for our systemic risk measures using idiosyncratic bank characteristics and country control variables. Our results comprise highly significant drivers of systemic risk in the European banking sector and have important implications for bank regulation. We argue that banks which receive state aid and have risky loan portfolios as well as low amounts of available liquid funds *contribute* most to systemic risk, whereas relatively poorly equity equipped banks, mainly engaged in traditional commercial banking with strong ties to the local private sector, headquartered in highly indebted countries are most sensitive to systemic risk.

1. Introduction

Which factors determine the interconnectedness of European banks? In this paper, we investigate the drivers of contagion and systemic risk among European banks using a large bank dataset with CDS quotes from 2005 to 2014. Banking *contagion* – a widely debatable issue – refers to the transmission of a bank shock to other banks or the financial system. It lies at the heart of *systemic risk*. Contagion is defined as a significant increase in cross-market linkages after a shock measured by the degree to which asset prices move together (Dornbusch et al., 2000). Earlier, Bagehot (1873) diagnosed that "in wild periods of alarm, one failure makes many, and the best way to prevent the derivative failures is to arrest the primary failure which causes them". To this end, we propose two novel measures of systemic risk through contagion using copula functions and credit default swap (CDS) data to capture the systemic impact that a single bank default has on the banking system (later *systemic risk contribution*) and vice versa (later *systemic risk sensitivity*). The topic of our paper is of considerable interest to regulators and economists as well: Our results offer new insights into the drivers of financial instability and provide implications for the macroprudential regulation of banks.

☆ The paper has been presented at 2015 Systemic Risk Tomography Conference Amsterdam. We thank the participants and the anonymous reviewers for their very useful contributions.

* Corresponding author. Tel.: +44 131 651 5312; fax: +44 131 650 8337.
E-mail address: Fernando.Moreira@ed.ac.uk (F. Moreira).

http://dx.doi.org/10.1016/j.intfin.2016.01.002
1042-4431/

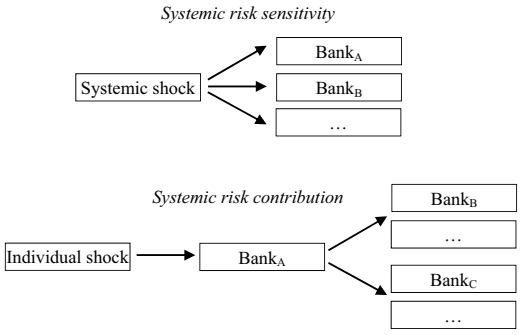

Fig. 1. Systemic risk contribution and sensitivity. This figure illustrates the two different contagion channels of systemic risk. Systemic risk sensitivity refers to an overall (macroeconomic) shock (change of a lead interest rate) that negatively affects each single financial institution. Systemic risk contribution refers to an individual shock in one bank (e.g., the default of an important borrower) that is transmitted into the whole banking system.

Financial systems as a whole tend towards instability. This is due to the fragile nature of their players, especially banks. Because of their role as a financial intermediary (or delegated monitor), their opaqueness, their interconnectedness, and the typical characteristics of their lenders, banks are particularly prone to affecting other banks with financial distress—or to being affected by them. Consequently, the identification of drivers of distress of systemically important banks (SIBs) is of vital importance. Recent papers on contagion among banks produced substantial findings. Dornbusch et al. (2000) and Acemoglu et al. (2015), among others, argue that financial contagion can be ambiguous: As long as the magnitude of negative shocks affecting financial institutions is sufficiently small, a more densely connected financial network (corresponding to a more diversified pattern of interbank liabilities) enhances financial stability. In this paper, however, we do not look at the network structure of interbank markets itself but focus on *systemic default contagion*. Existing literature in this field is comparably young and leaves questions unanswered: (1) First, it is unclear which channels of contagion systemic banking crises have. (2) Second, there is no consensus on how to identify SIBs. (3) Third, it is unknown how to measure the potential negative impact those banks can have on the financial system. We contribute to fill in these research gaps by proposing innovative key indicators to measure the extent to which single banks impact on the banking system and vice versa, as well as controlling determinants of those contagious procedures. This is carried out as follows:

Section 2 offers a review of the related literature on contagion and systemic risk (in Europe) as our background and starting point. The subsequent section presents our copula-based model to estimate systemic risk using CDS quotes. The bank selection and data collection are explained in Section 4. In Section 5, we derive key determinants of contagion in the banking sector, while Section 6 concludes our findings.

2. Related literature

In this section, we briefly discuss the related theoretical and empirical literature on using copulas for estimating contagion and identifying drivers of systemic risk in the European banking sector. Dornbusch et al. (2000) and Acemoglu et al. (2015), among others, argue that the ways in which bank shocks are transmitted do seem to differ, and these differences are important. We follow their line of thought and propose two novel measures of systemic risk.

The first step for the identification of drivers of systemic risk is the assessment of *systemic risk levels*. The number of measures for systemic risk is growing fast.[1] The existing literature can be divided into the (1) *systemic risk sensitivity* and the (2) *systemic risk contribution* stream. Approaches for (1) *systemic risk sensitivity* (Acharya et al., 2011; Brownlees and Engle, 2012; Jobst and Gray, 2013; Weiß et al., 2014) try to determine systemic importance by measuring the extent to which a single institution is affected in case of a systemic macroeconomic event (e.g., interest rate change); see Fig. 1. The overall functioning of the (financial) system and individual institutional resilience is in the focus of this first approach.[2] Conversely designed measures dealing with the (2) *systemic risk contribution* (Chan-Lau, 2010; Adrian and Brunnermeier, 2011; Billio et al., 2012; León and Murcia, 2013) try to determine systemic importance by measuring the impact of a negative shock in a single institution on systemic risk.[3] These measures assess how one institution affects a group of others; see Fig. 1. According to this understanding, it is of special interest to avoid and mitigate contagion effects.

Copulas (see definition in Section 3.1 ahead) have been applied in different ways in the context of systemic risk. Engle et al. (2014), for instance, use a particular copula (Student t) to represent the dependence across innovations of errors in a GARCH model related to firms' and regions' stock returns. CDS are increasingly used as a proxy for credit risk. Oh and Patton (2013)

[1] Bisias et al. (2012) provide a survey of systemic risk measures. Dornbusch et al. (2000) divide the empirical measures of contagion into the following categories: correlation of asset prices, conditional probabilities, and volatility changes.

[2] Examples are Marginal Expected Shortfall (MES), SRISK (the capital that a firm is expected to need in financial crises), Lower Tail Dependence (LTD) and Contingent Claims Analysis (CCA).

[3] Examples are ΔCoVar, Co-Risk, and Granger Causality.

Please cite this article in press as: Kleinow, J., Moreira, F., Systemic risk among European banks: A copula approach. J. Int. Financ. Markets Inst. Money (2016), http://dx.doi.org/10.1016/j.intfin.2016.01.002