Journal of Financial Stability xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Journal of Financial Stability

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

Information contagion and systemic risk☆

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ARTICLE INFO

Article history:
Received 8 May 2016
Received in revised form 1 November 2016
Accepted 11 May 2017
Available online xxx

JEL classification:
G01
G11
G21

Keywords:
Information contagion
Counterparty risk
Common exposure
Portfolio choice
Interbank market

ABSTRACT

We examine the effect of ex-post information contagion on the ex-ante level of systemic risk defined as the probability of joint bank default. Because of counterparty risk or common exposures, bad news about one bank reveals valuable information about another bank, triggering information contagion. When banks are subject to common exposures, information contagion induces small adjustments to bank portfolios and therefore increases overall systemic risk. When banks are subject to counterparty risk, by contrast, information contagion induces a large shift toward more prudential portfolios, thereby reducing systemic risk.

1. Introduction

Systemic risk is the risk of joint default of a substantial part of the financial system, resulting in large social costs.[1] One major source of systemic risk is information contagion: when investors are sensitive to news about the health of the financial system, bad news about one financial institution can adversely spill over to other financial institutions. For instance, the insolvency of one money market mutual fund with a large exposure to Lehman Brothers spurred investor fears and led to a widespread run on all money market mutual funds in September 2008.[2] As information contagion affects various financial institutions including commercial banks, money market mutual funds, and shadow banks, we adopt a broad notion of financial intermediaries and call them banks for short.

An investor in one bank will find information about another bank's profitability valuable for two reasons. First, both banks may have common exposure to an asset class, such as risky sovereign debt or mortgage-backed securities. Learning about another bank's profitability helps investors assess the profitability of its bank (Acharya and Yorulmazer, 2008b). Second, a bank may have lent to another bank, for example to share liquidity risk (Allen and Gale, 2000). Learning about the debtor bank's profitability will help investors in the creditor bank assess its counterparty risk.

☆ The authors wish to thank Viral Acharya, Jose Berrospide, Falko Fecht, Douglas Gale, Prasanna Gai (discussant), Paul Glassermann (discussant), Itay Goldstein, Todd Keister, Anton Korinek, Yaron Leitner, Ralf Meisenzahl, Jean-Charles Rochet, Cecilia Parlatore Siritto, Javier Suarez, Ernst-Ludwig von Thadden, Dimitri Vayanos, Tanju Yorulmazer, and seminar participants at the IMF, LSE, NYU, the Philadelphia Fed and conference participants at the RBNZ-UA "Stability and efficiency of financial systems" conference, the 2012 FDIC Bank Research Conference, and EEA 2011 meeting for fruitful discussions and comments. All remaining errors are our own. These are the views of the authors and do not necessarily reflect the views of the Bank of Canada or Deutsche Bundesbank. Co-Pierre Georg gratefully acknowledges financial support from Economic Research Southern Africa. Use was made of the University of Cape Town ICTS HPC cluster. Support by UCT's ICTS team is gratefully acknowledged.

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[1] The Bank for International Settlements (1997) compares the cost of systemic bank crises in various developing and industrialized countries and documents the range from about 3% of GDP for the savings and loan crisis in the United States to about 30% of GDP for the 1981–87 crisis in Chile.

[2] Lehman Brothers failed on September 15, 2008 and the share price of the Reserve Primary Fund dropped below the critical value of US$1 on September 16, 2008. See Brunnermeier (2009) for an overview.

http://dx.doi.org/10.1016/j.jfs.2017.05.009
1572-3089/

We develop a model of systemic risk with information contagion based on classical banking models (Diamond and Dybvig, 1983; Allen and Gale, 2007). Our model features two banks, and systemic risk is defined as the probability of joint default. We contrast the cases with and without the arrival of information about the other bank. Due to counterparty risk or common exposures, bad news about one bank can trigger the default of another bank. Information contagion is the amount of a bank's additional fragility due to such bad news.

A key channel in our model is the effect of ex-post information contagion on the ex-ante choices of banks and the implied level of systemic risk. Banks in our model have three choices: the design of the demand-deposit contract (the interim-date withdrawal amount), the portfolio choice between liquid but low-return and illiquid but high-return assets, and the amount of interbank insurance against liquidity risk.

Since a closed-form analytical solution cannot be obtained in many economically interesting cases, we compute the equilibrium of the withdrawal game for any choice of parameters numerically. Our numerical algorithm is simple and robust. We discretize the choices of the bank in the first region. Then, we compute the best response of the bank in the second region and use it to compute the first bank's best response to the second bank's best response. If the first bank's best response equals the original portfolio choice, we have found an equilibrium allocation because of symmetry. We incur a small numerical error by discretizing the portfolio choice. However, this error becomes smaller as we refine the grid of portfolio choice variables. Our numerical results are confirmed for several interesting special cases for which we do obtain closed-form analytical solutions, thereby providing additional intuition to our model.

For a given ex-ante choice made by banks, information spillovers mechanically increase systemic risk. Once the portfolio choice adjusts given the potential of information contagion ex post, however, the effect of information contagion on systemic risk depends on the reason why information is valuable for investors. We obtain two results. First, the overall effect of information contagion due to common exposure is an increase in systemic risk (Result 1), which we label the *instability effect*.

Second, information contagion due to counterparty risk, by contrast, reduces systemic risk. Banks respond by making more prudent ex-ante choices to counteract ex-post information contagion. Banks choose to expose themselves less to counterparty risk by engaging in less liquidity co-insurance and hold more liquidity themselves. Overall, this reduces systemic risk (Result 2), which we label the *resilience effect*. The direct detrimental effect of information contagion on systemic risk is more than fully compensated for by an indirect beneficial effect via the ex-ante portfolio choice. Overall, systemic risk in the financial system is lower.

Taking these results together, the effect of information contagion on the level of systemic risk – via changes in banks' ex-ante choices in their portfolios and demand-deposit design – depend on the nature of the interbank linkage. While financial fragility increases when banks are linked via common exposure, financial fragility decreases when banks are linked via counterparty risk.

One of our contributions is to study information contagion due to counterparty risk and its effects on banks' ex-ante choices and systemic risk. Counterparty risk as a source of information contagion and its consequences for ex-ante choices have not been consistently studied before. Cooper and Ross (1998) and Ennis and Keister (2006) study the effect of ex-post individual bank runs on the ex-ante liquidity choice and the design of deposit contracts. By contrast, we analyze how information contagion due to counterparty risk affects banks' ex-ante portfolio choice and deposit contract design and examine the consequences for banks' joint default probability.

Our counterparty risk mechanism builds on the literature of financial contagion due to balance sheet linkages. Building on Diamond and Dybvig (1983) and Allen and Gale (2000) describe financial contagion as an equilibrium result.[3] Interbank lending insures banks against a non-aggregate liquidity shock and potentially achieves the first-best outcome. However, a zero-probability aggregate liquidity shock may spread through the entire financial system. While counterparty risk in our model also arises from the potential default on interbank obligations, we obtain the ex-ante portfolio choice since contagion may occur with positive probability.[4] Dasgupta (2004) also shows the presence of financial contagion with positive probability in the unique equilibrium of a global game version of Allen and Gale (2000), focusing on the coordination failure initiated by adverse information. By contrast, we study the impact of information contagion from counterparty risk on banks' ex-ante portfolio choice, which is only partially addressed in Dasgupta (2004). Furthermore, our focus is on the consequences for systemic risk, and we also study the role of common exposures.

Our results also relate to the literature on information contagion due to common exposures. An early model of information-based individual fragility is Jacklin and Bhattacharya (1988). Chen (1999) shows that bank runs can be triggered by information about bank defaults when banks have a common exposure. Uninformed investors use the publicly available signal about the default of another bank to assess the default probability of their bank. In Acharya and Yorulmazer (2008b), information about the solvency of one bank is a signal about the health of other banks with similar exposure. The funding cost of one bank increases after adverse news about another bank because of correlated loan portfolio returns. Other models of common exposure include Acharya and Yorulmazer (2008a), who analyze the interplay between government bail-out policies and banks' incentives to correlate their investments. Anticipating ex-post information contagion induces banks to correlate their ex-ante investment decisions, endogenously creating common exposures.[5] By contrast, we consider counterparty risk as a principal source of information contagion. We also allow for a larger set of portfolio choice options. While interconnectedness of banks only arises through the endogenous choice of correlated investments in Acharya and Yorulmazer (2008b), we maintain the exogenous correlation of the bank's investment returns as in Acharya and Yorulmazer (2008a) but endogenize liquidity holdings, interbank liquidity insurance, and insurance taken out by early investors against idiosyncratic liquidity shocks.

Leitner (2005) studies the beneficial insurance effects of ex-post financial contagion in the absence of explicit ex-ante risk sharing mechanisms due to limited commitment. Agents with high endowments are willing to bail out agents with low endowments, since the threat of contagion outweighs the costs of the bail-out. While the reaction to ex-post contagion is an ex-post bailout in Leitner's model, we focus on the ex-ante changes in bank choices due to ex-post information contagion under commitment. While both models consider contagion due to counterparty risk, the timing of agents' internalization of the threat of contagion is different. Agents in our

[3] Freixas et al. (2000) consider spatial instead of intertemporal uncertainty about liquidity needs.

[4] Postlewaite and Vives (1987) show the uniqueness of equilibrium with positive probability of bank runs in a Diamond and Dybvig (1983) setup with demand deposit contracts. By contrast, we study the impact of information contagion from counterparty risk and common exposures on the ex-ante portfolio choice and systemic risk.

[5] Another consequence of having a common exposure is studied in Wagner (2011), where joint liquidation of an asset induces investors to choose heterogeneous portfolios and forego diversification benefits.

Please cite this article in press as: Ahnert, T., Georg, C.-P., Information contagion and systemic risk. J. Financial Stability (2017), http://dx.doi.org/10.1016/j.jfs.2017.05.009