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Financial Contagion-A Contributor to Systemic Risk

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***Abstract**: In financial markets, the tendency for bank-specific risks to spillover to other banks and to the rest of the economy is regarded as contagion. Understanding how contagion works among financial institutions is currently a top priority for regulators and policy makers in the financial sector. In this review paper we look at Contagion Risk and its characteristics. Cross-border linkages among banking systems of different countries are undoubtedly related to transmission channels of systemic risk. Larger cross-border exposures are likely to increase bank risk.One main cause 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 unfavorably leak over to other financial institutions. Ultimately, policy makers and regulatory authorities have an important role in controlling Financial Contagion.*
***Keywords:**Financial Contagion, Interbank Network, Systemic Risk, Interconnectedness.*

I. Introduction

The confusion that hit in the world's financial systems in the summer of 2007 has spurred a new debate on bank fragility andcontagion. In financial markets, the tendency for bank-specific risks to spillover to other banks and then to the rest of the economy is regarded as contagion [1].The concept of bank fragility generally refers to increased bank risk taking, leading to higher probability of default.Since the collapse of Lehman Brothersin 2008, the assessment of systemic risk turned out to be critical for decision makers, since regulators started to assess the effectsof small, fragile, and apparently secluded portfolios from one financial institution in compromising the safety and soundness ofother institutions.Understanding how contagion works among financial institutions is currently a top priority for regulators andpolicy makers who need put in place frameworks for the prevention of financial crises.

Banks and their interbank exposures create a so-called interbank network, where banks represent the nodes and financial exposures create the links between those nodes. The strength of such a network depends on both the financial soundness of individual banks and the framework of the interbank links within the network. Therefore, network analysis is employed in order to understand the structure of an interbank market.The collapse of the inter-bank market at the beginning of the crisis suggests that directlinkages between banks are an important channel of contagionacross financial institutions [1].

Modern financial systems show a complex network structure: banks can conduct credit lending with other banks, firms can be linked with other firms to buy or sell products, and firms can also connect with banks through bank loans.Connectedness of entities is essential to systemic risk as it lies at the heart of the spread of shocks around the economy.The recent Eurozone sovereign debt crisis emphasized the significance of cross-border linkages in spreading local conditions across national borders [2]

We assume three possible channels of interbank contagion: a credit channel, a liquidity channel, and an asset price channel. The credit channel exists when banks in the system are collapsing due to credit losses on interbank exposures. Moreover, a bank might collapse when it is illiquid, i.e., when liquid assets such as cash, central bank balances, interbank lending are not adequate to cover short-term interbank liabilities. Lastly, the asset price channel exists when government bonds are no longer thought of as highly liquid assets, and therefore it is not possible to exchange these bonds for cash without a rebate.

Significantevidence not only for the existence of contagion between bankingsectors, but also for its role in promoting banking crises in regionsgeographically removed from the crisis source. There is a growing body of literature examining the role of banks inthe transmission of financial crisis of 2007–2009, most of whom findevidence of international transmission via the banking sector [3].Banking crises are costly, and a great deal of prudential effort is carried out to avoid them. It is estimated that losses ofabout 6 percent of GDP related with a banking crisis in the lastquarter of the 20th century, whilst [4] documentlosses of about 30 percent of GDP throughout the Global FinancialCrisis of 2007–2009 [3].

There is a developing literature on contagion risk in interbank networks. The influential papers of Allen and Gale [1] and Freixas et al. [5] develop some of the first proper models of contagion risk in interbank networks.There are many important studies in this area, such as Nier et al.[6] , May and Arinaminpathy [7] , Gai et al. [8] , Lenzua and Tedeschi [9] , Mastromatteo et al. [10] , Chen et al.[11]. Most of the above researches take the interbank network as an exogenous structure. Recently, there are many studies on endogenous networks of banking systems. For instance, Halaj and Kok [12] present the model of network formation under optimizing bank behavior; Bluhm et al. [13] develop a network model whose links are governed by banks' optimizing decisions and by an endogenous market adjustment.

In order to appreciate the fragility of the economy, researchers have studied the contagion effect among firms from both the aggregate and firm level perspectives [14]. Some empirical studies show that there is contagion risk among firms [15].Furthermore, there is a lot of literature on inter-firm contagion risk from the perspective of network methods.Studying contagion risk in financial networks is very important for establishing the stability of financial systems.

II. Interconnectedness & Channels of Contagion

Banking has become more international over the recent two to three decades. This development can have beneficial effects, such as directing monetary resources to their most productive uses or improving consumption smoothing and risk-sharing possibilities. However, it also raises a broad range of questions. One of the biggest worries is that does cross-border connections in banking make countries more susceptible to contagion risk?

Allen and Gale's [1] model of bank contagion addresses the role of interbank lending; not by focusing on peer monitoring though, but rather by focusing on the physical exposures among banks in different regions and the real linkages between regions, as represented by the correlation of liquidity needs of the respective depositors. Since only symmetric equilibria are analyzed by the authors, each of the four regions considered can be characterized by one representative bank, taking in period 0 retail deposits (insuring depositors against liquidity shocks), lending or borrowing in the interbank market and investing in (non-risky) short or long term projects of outside firms (loans).

In the first period depositors whose region faces a negative liquidity shock withdraw. The bank can meet the withdrawals from maturing short-term investments, by liquidating interbank deposits it made earlier in other regions (if it is long in the interbank market), or as a last resort at a high cost, if the other two options are exhausted by liquidating long-term project lending. In period two long term projects mature, interbank and retail deposits are reimbursed, except for those banks that became bankrupt since not all retail or interbank deposit withdrawals could be served.

Cross-border linkages among banking systems of different countries are undoubtedly related to transmission channels of systemic risk. Larger cross-border exposures are likely to increase bank risk. In contrast, higher levels of diversification can have counterbalancing effects. In this study by Tonzer [2]. It is evident that countries that face foreign interbank exposures to more stable counterparties tend to experience a shift toward a more stable banking system. This highlights that bilateral linkages can have a beneficial effect on stability.

There are some main components that have been identified to conceptually model systemic risk: first, an initial random shock which affects one or more financial institutions and second, a contagion mechanism which transmits such negative effects to other institutions on the system. The contagion mechanisms are multiple, for example, the payment systems or the interbank market, just to mention two of the most studied contagion mechanisms [16].

Contagion can take place through plenty of channels as summarized in table 1. However, we focus on one channel, and that is direct effects due to losses on interbank loan exposures. Several of cases of authorities bailing out financial institutions in order to prevent failure by contagion.

Table 1. Channels of Contagion in the banking system. [17]

Likely Channels of Contagion in the Banking System
CHANNEL
Liability Side
Bank Runs
Multiple equilibria/fear of withdrawals
Common pool of liquidity
Information about Asset quality
Portfolio rebalancing
Fear of direct effects
Strategic behaviour of potential lenders
Asset Side
Direct Effects
Interbank Lending
Payment System
Security Settlement
FX Settlement
Derivative Exposures
Equity Cross holdings
Indirect Effects
Asset Prices

The balance sheet perspective gives a new understanding into the nature of financial contagion in the modern, market-based financial system. Aggregate liquidity can be understood as the rate of growth of aggregate balance sheets. When financial intermediaries' balance sheets are normally strong, their leverage is too low. The financial intermediaries hold excess capital, and they will try to find ways in which they can employ their excess capital. On the liabilities side, they take on additional short-term debt. On the asset side, they pursue potential borrowers that they can lend to. Aggregate liquidity is closely tied to how hard the financial intermediaries search for borrowers. In the subprime mortgage market in the United States we have seen that when balance sheets are expanding fast enough, even borrowers that do not have the means to repay are granted credit –so intense is the urge to employ surplus capital. The seeds of the subsequent downturn in the credit cycle are thus shown.

The likelihood of contagion may be contingent on the exact structure of the interbank market. If we contemplate a lending framework that has four banks that hold claims on each other. In case of a shock in the market some structures will result in contagion while others will not. In actual fact a situation where every bank is linked to every other bank in the environment, these banks will most likely have a lower chance of facing contagion than banks in a structure where they are linked to fewer say one or two banks only. These have a higher chance of facing contagion. However, isolated banks are also less likely to spread contagion.

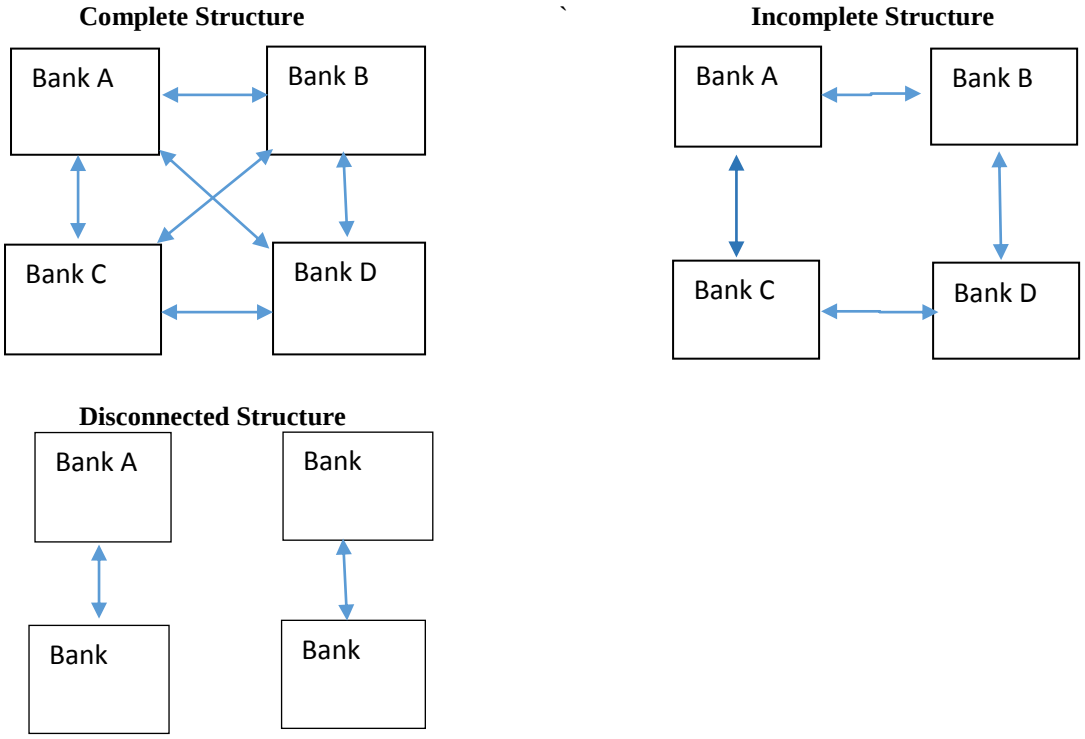

Fig. 1 Network Structures of the interbank market.

Direct interconnections between financial institutions are a dominant driver of systemic risk. Though non-monotonic, increasing interconnectedness tends to be associated with increasing levels of systemic risk and banks' contribution to it. The interbank market thus deserves high attention in any systemic risk analysis. Second, the fire sale channel is an important amplifier of exogenous shocks and can strongly influence out-comes. Depending on the price sensitivity to non-liquid asset sales, even tiny shocks may be amplified by this indirect contagion channel, putting the entire financial system at risk. In light of this result, marking-to-market accounting in times of financial turmoil may amplify distress risk in the financial system. Howeverthis analysis also provide evidence that ceteris paribus increasing banks' holdings of liquid assets alleviates the contagious effects of the fire sale channel [13].

The interest in contagion has clearly gained impetus during the global financial crisis, but it is not new. The sell-offs in emerging markets after the Mexican peso crisis in late 1994 and the Asian crunch in 1997 triggered a large amount of literature on contagion in financial markets.The absence of concrete empirical evidence on whether contagion is possible poses problems for central banks and other authorities in charge of maintaining the stability of the financial system.

Economists studying contagion have therefore resorted to simulation methods to test whether, given a particular set of exposures, failures could have knock-on effects. Initially such simulations were done on individual institutions to gauge whether these institutions could withstand contagion, and not whether an entire banking system could withstand contagion.

In contrast to much of the previous literature the network was not subjected to ad hoc shocks of different sizes. Instead he assumed a full-fledged shock distribution and study the likelihood of default cascades and consequent losses of value that are attributable to network connections [18].

Systemic risk can be usefully decomposed into two components:

(i) the probability that a given set of nodes D will default and

(ii) the loss in value conditional on D being the default set.

This decomposition allows us to distinguish between two distinct phenomena: contagion and amplification. Contagion occurs when defaults by some nodes trigger defaults by other nodes through a domino effect. Amplification occurs when contagion halts but the losses among defaulting nodes keep rising because of their indebtedness to one another. Roughly speaking the first effect corresponds to a ''widening'' of the crisis whereas the second corresponds to a ''deepening'' of the crisis.

It is quite evident that contagion has a wide ranging effect as it not necessarily only affects the region where the crises begun but also other areas and as far out as other countries.

Although the crisis is often seen as having origins in overheated housing markets and the associated mortgage backed securities market, it is important to concentrate on the international transmission of this stress which is due to the financial intermediaries rather than the localized housing markets themselves. We find significant evidence not only for the existence of contagion between banking sectors, but also for its role in promoting banking crises in regions geographically removed from the crisis source [19]. There is a growing body of literature examining the role of banks in the transmission of financial crisis of 2007–2009, most of whom find evidence of international transmission via the banking sector.

Banking sectors across the world were disturbed by the severity of the 2007–2009crisis and were not immune to contagion effects. About 60 percent of the sample banking markets experienced a break in global systematic risk exposure, and about 60 percent of banking markets experienced idiosyncratic contagion originating from the US banking market [20].

When implementing policy proposals, it is evident that financial stability policymakers have faced a number of practical challenges. First among these is how best to monitor financial systems and the broader economy to detect signs of vulnerabilities that might lead to future bouts of financial instability of the stability of the whole system [21].

Policymakers find themselves relying on the experience of other countries, which might not be relevant to their own systems. There is very little theoretical or other comparative work on whether and where institutional differences can affect the optimal policy framework or setting for financial stability.

III. Information Contagion

Systemic risk is the risk of joint default of a sizeable part of thefinancial system, ensuing in large social costs.One main causeof systemic risk is information contagion: when investors are sensitive to news about the health of the financial system, bad newsabout one financial institution can unfavorably leak over to otherfinancial institutions. Information contagion affects various financial institutions including commercialbanks, money market mutual funds, and shadow banks amongst other intermediaries.

An investor in one bank will search for information about another bank's profitability valuable for two reasons. First, both banks mighthave common exposure to an asset class, such as risky sovereigndebt or mortgage-backed securities. Learning about another bank'sprofitability aids investors evaluate the profitability of its bank[22]. Second, a bank may have loanedto another bank, for example to share liquidity risk [1].Learning about the debtor bank's profitability will helpinvestors in the creditor bank assess its counterparty risk.

A model of systemic risk with information contagion is offered. News about the health of one bank is valuable for the investors ofanother bank due to shared exposures or counterparty risk. Ineach case, bad news about one bank unfavorably spills over to otherbanks and causes information contagion. A study done on the effects onthe bank's ex-ante choices and the inferred level of systemic risk demonstrates that information contagion can lessensystemic risk. When banks are subject to counterparty risk, investorsin one bank may receive a negative indication about the health ofanother bank. Given the exposure of the creditor bank to the debtorbank, adverse information about the debtor bank can cause a runon the creditor bank. Such information contagion ex-post inducesthe bank to hold a more prudent portfolio ex-ante. Banks reducetheir exposure to counterparty risk and rely more on self-insuranceof liquidity instead of co-insurance. Overall, the level of systemicrisk is actually reduced with information contagion. Furthermore, theeffects of information contagion on systemic risk depend on thesource of the revealed information. The case of common exposures,ex-post information contagion increases systemic risk [19].

In recent years, banks and other financial institutions have made a big investment of credit derivatives in credit asset market to meet the customers' various demands of investment and financing, and in addition bring about profits. However, with the rapid growth of credit asset market and its business scope, particularly after the occurrence of the US subprime crisis and the European debt crisis, counterparty credit risk caused by the excessive expansion of credit derivatives is weakening and its impact is becoming more complex. Academics define Counterparty Credit Risk (CCR) as the risk of economic loss due to a counterparty default before the contract runs down, which is caused by market risk and symbolizes credit risk [23].

In terms of Information disclosure strategy the market information is often misleading and irregular and the market subjects have limited ability of cognition and judgement. The corresponding channel of counterparty credit risk contagion is information spillover effect. Investor behaviour and Information disclosure strategy not only have an effect on the formation and contagion of counterparty credit risk respectively, but also often have more complex influence on it under interaction.

IV. Contagion Measurement

Contagion and spillovers are sometimes used as synonyms, in the context of Financial Contagion.Contagion can be defined as the spillover effect occurring following a shock. In this setting, for contagion to occur, itneeds a trigger or a shock, which amplifies the interdependence or co-movement across variables. One of the means of contagion measurement involves evaluating the dynamics of international bank risk transmission by using an empirical method to measure contagion. In line with recent literature, some researchers use the credit default swap (CDS) spreads of major international banks as an indicator of bank creditrisk. CDS spreads have a number of advantages in proxing for credit risk, including a more accurate measurement of default risk and higher liquidity [24].

In this example contagion is estimated following a generalized vector autoregressive framework (GVAR) approach [24]. GVAR is a VAR-based spillover index mostly suited for the study of systems of highly interdependent variables.The methodology permits us to identify the dynamics of the interactions over time and to scrutinize both total and directionalspillovers. Furthermore, an innovative framework is proposed to differentiate between systematic and idiosyncratic contagion. Tothis end, Principal Component Analysis (PCA) is used to extract the common factors underlying the correlations among theCDS returns series of individual banks over the sample period. In this setup, systematic contagion captures the spillover effectsdue to changes in global factors that affect all banks, whereas idiosyncratic contagion measures the spillover effects caused bychanges in bank fundamentals. This decomposition enables us to assess to what extent the increase in bank fragility over the crisesperiod was driven by worsening bank fundamentals and bigger bank-specific risk taking or whether it reflected drop inglobal economic and financial conditions that affected all banks as an asset class. Evidence of contagion in banking markets is found, documented by an increase in co-movements in CDS returns andconfirmed by the results of the GVAR estimations. Contagion came in different waves, with the financial and Eurozone crises beingseparate episodes with different spillover dynamics. The results suggest that international linkages among bankingmarkets are centralto the spread of shocks. This measure of systematic contagion is always greater than the idiosyncratic component, thusstressing the significance of common factors in the propagation of risk spillovers.Taken together these findings seems to indicate that international linkages among banking markets are important for the transmission of shocks [25].

Another type of measurement of contagion was an analysis of interbank contagion within the Czech banking system that examined the systemic risk associated with the financial interconnectedness of Czech banks. The period in focus starts in March 2007, i.e., prior to the onset of the global financial crisis, and ends in June 2012. Two standard techniques were employed to assess the resilience of the Czech banking system to contagion. Firstly, network analysis that explores the sparse and heterogeneous structure of the Czech interbank market. Centrality measures used as proxies for individual bank importance in the network, i.e., degree, betweenness, and eigenvector, show that there are a few bigger banks that are important for the system and many relatively small banks on the periphery of the system. Knowledge of the network structure is not sufficient to assess the vulnerability of the banking system to contagion, since it does not allow for control of other important features of the banking sector, such as its capitalization and liquidity. Hence, a simulation approach was employed to address these financial issues. Secondly, using three alternative versions of the model which successively introduce individual contagion channels, i.e., a credit channel, a liquidity channel and an asset price channel, failures of individual as well as multiple banks were simulated. The simulation results of the initial idiosyncratic shockindicate that contagion due solely to credit losses on interbank exposures was very low over the period in focus. This contagion was less than 3% of the remaining banking sector assets and affected no more than two banks even in the worst-case scenarios. Introducing the liquidity condition into the model increases the impact of contagion. The average contagion affected less than 3.8% of the remaining banking sector assets, with the exception of the period from December 2007 to September 2008. Furthermore, the simulation results for both idiosyncratic and initial multiple bank failure shocks suggest that the potential for contagion in the Czech banking system has decreased since the onset of the global financial crisis [26].

V. Policy Makers and Regulatory Authorities Role in Controlling Financial Contagion

The idiosyncratic shocks channel is empirically an importantlink in spreading shocks across international banking sectors,and is closely related to the ensuing occurrence of a bankingcrisis in the recipient country. Concentrated banking sectors,strong regulatory capital requirements and a concentration inretail banking income help to reduce the likelihood of systemic crisis,consistent with the existing evidence. However, there is evidentlymore that can be done by policy in identifying anddefusing the transmission of country specific idiosyncratic shocksthat are potential sources of idiosyncratic contagion so as to reducethe costs of any consequent banking crises.

- **Capital and Liquidity Standards**

It is important to maintain capital and liquidity standards for large, complex firms to mitigate external shocks and the risks they pose to the economy. In particular we need to maintain our focus on firms whose impairment

would have a significant negative impact for the rest of the financial system. Effective capital and liquidity standards help to limit these adverse consequences.

- **Resolution**

We also must have an effective resolution mechanism that allows a firm to fail without threatening to bring down an entire financial system.

- **Reforms to Market Structure**

We should also keep in place key structural reforms of financial markets that are making the financial system safer. In my mind, the most important include money market mutual fund reform, tri-party repo reform, and the mandate for the centralized clearing of OTC derivatives [27].

VI. Conclusion

The tendency for bank-specific risks to spread to other banks and then to the rest of the economy is regarded as contagion [1]. Banks and their interbank exposures create a so-called interbank network, where banks represent the nodes and financial exposures create the links between those nodes. Most of the research done on Contagion risk on interbank networks assume them to be exogenous in nature, however there have been some that are endogenous.Cross-border linkages between banking systems of different countries are unquestionably related to transmission channels of systemic risk. Larger cross-border exposures are likely to increase bank risk. In contrast, higher levels of diversification can have counterbalancing effects.Contagion can take place through plenty of channels however, we focus on one channel, and that is direct effects due to losses on interbank loan exposures.There is a growing body of literature examining the role of banks in the transmission of financial crisis of 2007–2009, most of whom find evidence of international transmission via the banking sector.

One chief cause 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 unfavorably leak over to other financial institutions. Information contagion affects various financial institutions including commercial banks, money market mutual funds, and shadow banks amongst other intermediaries.Contagion measurements are essential in ascertaining the level of contagion in a system. One of the means of contagion measurement involves evaluating the dynamics of international bank risk transmission by using an empirical technique to quantify contagion. Another type of measurement of contagion seen here was an analysis of interbank contagion as was used in the Czech banking system that examined the systemic risk associated with the financial interconnectedness of Czech banks [25].

Policy makers and regulatory authorities have a role in controlling Financial Contagion and this includemaintaining capital and liquidity standards for large, complex firms to mitigate external shocks and the risks they pose to the economy. Secondly, having an effective resolution mechanism that allows a firm to fail without threatening to bring down an entire financial system and keeping in place key structural reforms of financial markets that are making the financial system safe.

In this review we look at the definition of Contagion, Contagion channels and Interconnectedness, we define Information Contagion, delve into the different measurement techniques of contagion and lastly the regulatory authorities' role in Contagion management. It is quite evident that the resilience of a network depends on both the financial soundness of individual banks and the structure of the interbank links within the network.Maintaining sound macroeconomic fundamentals, a clear legal framework and strong prudential oversightare preventative measures within the responsibility of domestic authorities.

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