Financial Systems, Micro-Systemic Risks and Central Bank Policy: An Analytical Taxonomy of the Literature

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Financial Systems, Micro-Systemic Risks and Central Bank Policy: An Analytical Taxonomy of the Literature[1]

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[1] This paper provides an encyclopaedic analytical afterthoughts on banking crises and financial contagion. Excerpts of this paper were produced by myself as part of my PhD internship at the Bank of England, Summer 2005.

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Abstract

This paper reviews and categorises the literature on micro-systemic risks and on optimal policies designed to mitigate these risks. Micro-systemic risks are risks to the financial system that occur when the interaction of a bank with other banks or with financial markets, can propagate an initially localised shock to the whole financial system and can prevent the latter from fulfilling its intermediation and distributional roles. The severe episodes of financial crises that have plagued economies - developed and emerging markets alike - have made more compelling, the need for policymakers such as central banks, to develop prudential tools as part of crisis prevention and crisis management policies. We review the success of these policies under different theoretical paradigms. The paper ends with a brief synopsis of financial accelerator models which stress on how imperfections in financial markets may magnify the swings and intensity of business cycles and have a more entrenched impact on the macroeconomy.

Keywords: *Microsystemic Risks, Financial Fragility, Financial Accelerator*

JEL Classification: *G20, G28*

SECTION A: FINANCIAL CRISIS INITIATORS

1. Introduction to Literature on Financial Fragility

There is no "one-size fits all" definition of what constitutes financial instability. Many observers will view a financial system as being stable if it shows much resilience and ability to resist a crisis due to a shock to either one institution within the system or to the whole system, within which all institutions operate. The pitfall with this doctrine is that financial instability is merely viewed as an "egg from which crises are hatched" – what "resilience" and "ability to resist a shock" mean, are not carefully defined. Thus, this stripped-down version is primarily viewing financial instability from the vantage point of a financial crisis. From this perspective, any systemic event that causes economic loss of value that is strong enough to cause serious disruption to real economy, will be categorised as instability.

Haldane, Hall, Saporta and Tanaka (2004) argue, such a definition ignores the other possible ways financial instability may manifest itself. They argue that three non trivial issues would be absent from such a narrow perspective: (1) the *initiator* of a crisis; (2) the *propagator* of the crisis and (3) the existence of *financial frictions* which magnify the amplitude and frequency of crises, in a way that systematically alters the dynamic path of the economy. Haldane et al (2004) propose a holistic version of financial instability that nests the notion of a crisis within these three issues. If the essence of a financial system is to allocate resources efficiently across time, across states of nature and to ensure smooth and efficient financing of investment projects and efficient pricing of risk, then a financial system will be viewed as financially stable if it guarantees the fulfilment of these functions, even in the presence of a shock. Financial fragility will thus be viewed as one in which one or more of these functions become dismantled, due to shocks to the system. Through interactions with financial frictions, these shocks alter the dynamics of a crisis and give well defined shape to its anatomy.

This holistic version of financial fragility encompasses the analysis of systemic risks involving financial intermediaries or banks. There are two aspects of systemic risk that the literature identifies: microsystemic risks and macrosystemic risks. The former can be defined as: "*risks to the financial system that occur when the interaction of a bank with other banks or with financial markets, can propagate an initially localised shock to the whole financial system, by subjecting the derived analytics of the crisis, as an endogenous part of the theory*[2]*"*. It is this particular form of systemic risk with which we are concerned in this paper. The difference between the different interacting units that make up the financial system is important and any macroeconomic variable is taken as given or fixed. Macrosystemic risks, on the other hand side, can be defined: "*risks occurring when, through the presence of financial frictions or imperfections, a financial system's interaction with the macroeconomy, can magnify the frequency and intensity of crises and have a more entrenched impact*

on key macro variables (e.g real business cycle)[3]*".* With macrosystemic risks, the difference between different financial intermediaries is immaterial. It is thus theoretically possible to consider financial intermediaries as a single unit. What matters is the impact that financial intermediation has on macroeconomic variables and how, the presence of financial frictions that give rise to intermediation, can affect macroeconomic variables[4].

The need to mitigate systemic risks in a financial system, is one of the most important reasons behind the enactment of prudential banking regulatory policies. Measures may be implemented either *ex-ante*, as part of systemic-risk prevention or *ex-post,* as part of systemic-risk management. While the former concerns the institution of rules or standards that makes the financial system more "crisis-proof", the latter concerns the instigation of policy measures to stall a crisis once the symptoms of its occurrence start to appear[5]. It is worthwhile mentioning, though, that policy measures designed to stall a systemic crisis, are not without pitfalls. While they may be benign in preventing the fully blown impact of a system-wide crisis on output and on financial intermediation, they may cost a lot in terms of taxpayers' money and have an adverse impact on incentives of key stakeholders in the financial system.

Thus, if the costs of preventing a system-wide crisis are higher than the costs that the banking crisis itself entails to output and intermediation, then it does not make sense to regulate or impose policy measures. To be able to assess this cost and benefit of policy mitigation in a systematic way, we need a framework that juxtaposes both issues in one setup and that assesses the net benefit of policy measures in a welfare-theoretic sense. Fortunately, microeconomic analysis is helpful at providing that insight and helps assess how successful different policy measures are at tackling system-wide risks and whether they help restore the first-best allocation of resources.

Following the above definition for microsystemic risks, the paper is organised under two main section. The first section, Section A, deals with financial crisis initiators. Here, the literature for financial fragility for the one-bank case, is reviewed and various policies designed to mitigate bank runs, reviewed and contrasted. Because most models of systemic risk involving bank runs, almost always start with a technological or liquidity shock occurring at one bank, it is useful to have an overview of the implications of this literature for policy mitigation. The second section, Section B deals with propagators of a crisis. Here, we go beyond the confines of the one-bank scenario to include cases involving multiple banks or involving an interaction between banks and financial markets. In these models, there exist several avenues, through which a bank failure may spread to other banks. Banks are often connected through the existence of overlapping financial contracts such as the interbank market in deposits or loans. Sometimes, they can interact with financial markets as well. In the absence of market failures, the interbank market or the financial market will allocate resources efficiently. Cash-

[2] This definition is based on my own personal interpretation and quoted from my presentation slides, in a seminar held at the Bank of England, September 2005

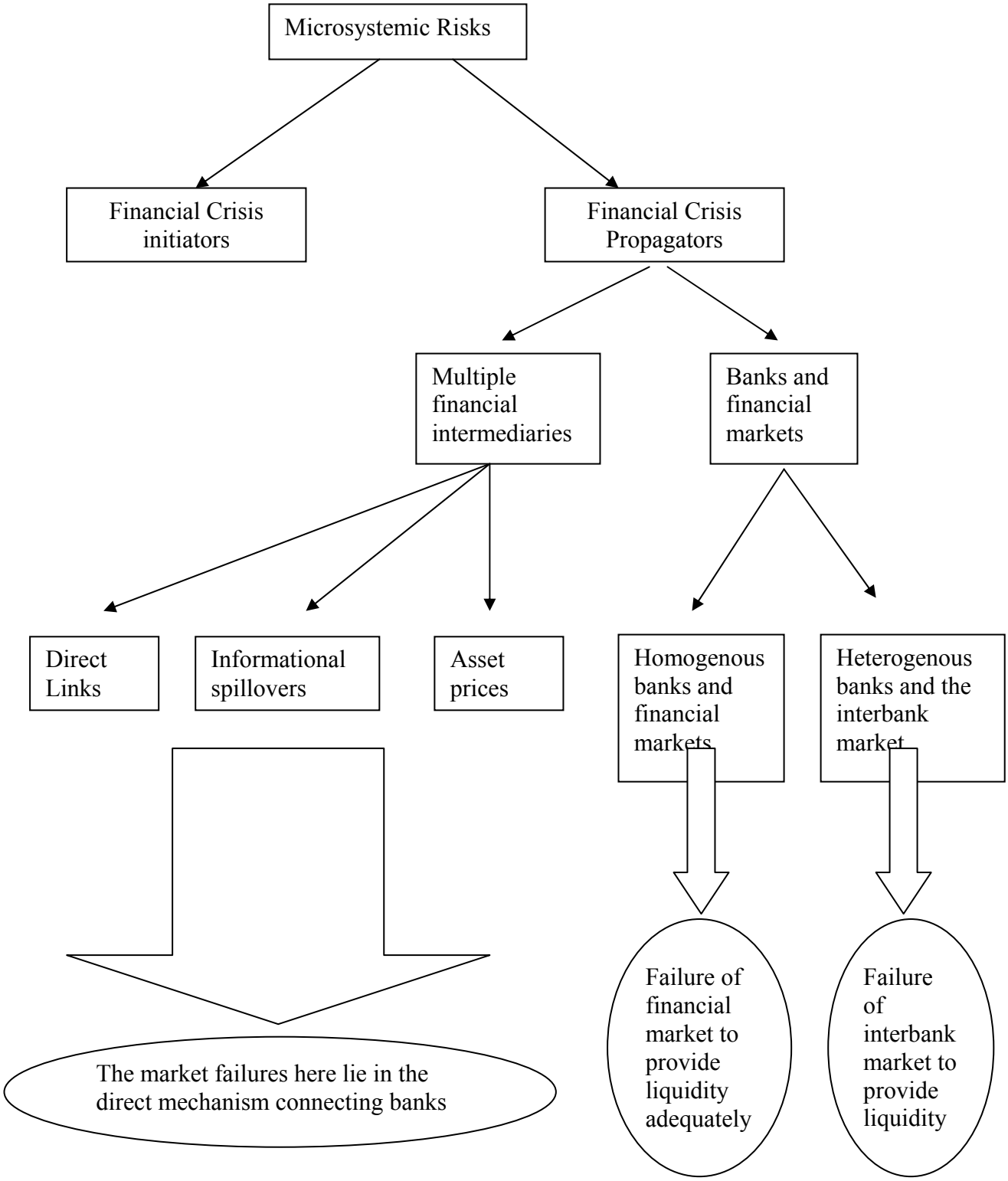
[3] See footnote 1 above.

[4] For a survey of the literature on macrosystemic risks, please see Haldane et al. (2004)

[5] While it is not the purpose of the paper to review the literature on banking regulation, see section (.) of the appendix for a brief overview.

strapped banks will always be able to get their way out of liquidity troubles. If markets failures exist though, liquidity provision by the interbank market or by financial markets in general, may be inadequate. The illiquidity problem at one bank may contagiously spread to other banks connected to it through financial contracts or the illiquidity problem may turn into an insolvency one. In both cases, the existence of market failures will warrant a case for central bank intervention as a way of mitigating these crises amplifications. It is the purpose of this paper to categorise the literature therein, unearth the market failures responsible for the crisis propagation and assess how policy measures are successful in mitigating systemic-risk . The roadmap is represented in the following chart:

Chart 1: Roadmap of Microsystemic Risks Taxonomy



2. Literature on Financial Fragility and Coordination Failure

2.1 Liquidity Insurance Provision

Banks are special compared to other institutions in that they are "dealers in financial contracts" (Freixas & Rochet (1997)), which are non-marketable, compared to other financial securities such as bonds and shares : they act as intermediaries between firms that are cash-strapped and that need to borrow (issuers of financial securities) and investors, who have excess cash and who wish to part off with that excess liquidity temporarily (recipients of financial securities). Thus, the nature of a bank's activities means that it is linked to its stakeholders through contracts. The features that these contractual arrangements have for the bank's balance sheet, are categorised as follows:

- Maturity mismatch - assets (e.g loans) are illiquid and liabilities (e.g deposits) are liquid;
- Liquidity-profitability mismatch - the more illiquid the assets, the higher the return on the asset;
- High gearing and relatively low capitalisation - deposits being very high relative to equity;
- Creditors (i.e. depositors) are actually the bank's clients.

These features distinguish a bank from a number of other institutions and expose it to an array of risks[6]. Consumers deposit their endowments in the bank but face uncertainty about the timing of their consumption. The problem that banks face is to try to match the structural features described above with the uncertainty about the timing of consumption by depositors. By offering demand deposit contracts, they can do that. Since the work of Diamond and Dybvig (1983) on bank runs and liquidity provision, there has been a surge in the literature of bank runs and on panic transmission. Diamond-Dybvig (1983) contributed significantly to our understanding of banking activities because it was the first paper to analyse bank failure from the intrinsic characteristics of a bank's balance sheet, as detailed above.

In this model, banks are seen as intermediaries, that accept deposits from households, pool these resources and invest them in technologies to which depositors individually do not have access to, and offer depositors a better combination of returns and liquidity services. The bank offers depositors demand deposit contracts that basically allow depositors to withdraw their deposits to meet any pressing liquidity needs.

Coordination failure has been rationalised as potential explanation for the behaviour of depositors. In a setting with the existence of a storage technology, a long term asset that can be liquidated prematurely

[6] These risks include: credit, market, liquidity and operational risks. A complete description of these risks is beyond the scope of this paper. Refer to Freixas and Rochet (1997), chapter 8, for more details.

and a sequential service constraint, each depositor of a given bank is concerned with what other depositors of the same bank are doing. Thus beliefs about each other's actions become important in decision making. This belief generated mechanism has a strong self-fulfilling element, such that multiple equilibria results.

The model of Diamond and Dybvig (1983) is as follows: There are three periods, time 0, 1, 2. In time 0, depositors invest their endowments in the bank. The latter invests the endowment in a short term liquid technology and a long-term illiquid technology and offers a demand deposit contract that depicts the amount the depositor will receive, following withdrawal of deposit. The illiquid technology yields a non-stochastic return of R in period 2. If liquidated prematurely (i.e time 1), it yields a return of r (< 1), thus representing a cost involved in early liquidation. There is also a short term liquid technology which yields a return of 1 (for every unit of endowment invested therein). Depositors are assumed to face a liquidity shock in period 1, which is independently and identically distributed among depositors. With probability λ, they may be impatient (i.e wish to consume early) and probability $1-\lambda$, they may be patient (i.e wish to consume late). The distribution of liquidity shocks is common knowledge, but the private realisation of the liquidity shock is private knowledge.

To see the improvement in consumption allocation, it is important to make a contrast between the three: in autarky, each individual is bound by his budget constraint and the absence of any markets whatsoever, means that he consumes less or equal to 1 if he is an impatient consumer and less or equal to R if he is a patient consumer. With a financial market allowing for the possibility of trading assets, a consumption stream of $(1,R)$ would be possible. Thus if the individual is impatient, he will sell his holdings of the long asset and consume the proceedings. If he is patient, he use the amount invested in the short technology to buy assets, which he can hold until period 2. Given equilibrium price for the financial asset, it can be seen that the market allocation coincides with the uppermost allocation, namely $(1,R)$. This represents a Pareto improvement over the autarky but has a setback. At period 0, each agent would prefer a consumption plan that trades some period 2 consumption for period 1 consumption. Thus, agents would like to receive some insurance against the risk of being impatient. The financial market cannot offer perfect insurance against the risk of being an impatient consumer. The rationale is that the set of markets being allowed for is incomplete. There is no market for contingent claims, on which the individual can trade liquidity for delivery in the interim period, contingent on his type.

Financial intermediaries can be seen to fulfil that liquidity insurance role, through demand deposit contracts. The crucial point is that, while individual depositors face the uncertainty in period 0 as regards their liquidity needs, a bank does not face such uncertainty. By the Law of Large Numbers (LLN), these idiosyncratic liquidity shocks will be mutualised and the proportion of early (late) withdrawals that the bank will face is exactly equal to λ ($1-\lambda$ respectively). Thus, if the bank follows a

fractional reserve system, it becomes clear that it will earmark a proportion of λ of deposits to the short asset and a proportion of 1-λ to the long asset.

If the bank faces excess early withdrawals (i.e withdrawals that cannot be met by the short assets alone), it will be forced to liquidate the long asset in period 1 in order to provide for the liquidity needs of those who withdraw early. Patient depositors know that since the long asset is liquidated, they may get a lower amount than promised by the demand deposit contract. They may therefore all have an incentive to withdraw early, thereby prompting a run on the bank[7].

Table 1: Consumption Profiles under Different Institutional Regimes

Institutional Regime	**Consumption in period 1**	**Consumption in period 2**
Autarky	≤ 1	≤ R
Financial Market with equilibrium price for financial asset traded	= 1	= R
(Diamond-Dybvig(1983) setup) Financial intermediary offering fixed demand deposit contract (Coefficient of relative risk aversion >1)	> 1	< R
Financial intermediary offering fixed demand deposit contract (Coefficient of relative risk aversion <1)	< 1	> R
Financial intermediary offering fixed demand deposit contract (Coefficient of relative risk aversion =1)*	= 1	= R

Note:

The optimal consumption profile in the Diamond-Dybvig (1983) set-up (first best) matches that of the financial market, in the situation in which the coefficient of relative risk aversion for depositors is equal to 1. In all other cases, there is a deviation of the financial market from the first best allocation.

2.2 Policy Implications in Models of Liquidity Provision

Banks offering fixed demand deposit contracts achieve the optimal risk-sharing allocation. But such a contract is very much susceptible to runs by cohorts of depositors, for reasons that have to do with extraneous variables (or sunspots), not explained within the model.. In the case of runs, the allocation is inferior to autarky. This trade-off between efficiency and stability that is inherent in the Diamond and Dybvig setup, has prompted research into possible ways to achieve the optimal (first-best) solution,

[7] Notice that the nature of a bank run arises from an interaction between four features of the model: (i) The existence of a storage technology; (ii) The possibility of liquidating the long asset; (iii) The existence of a sequential service constraint, as implicitly assumed by Diamond and Dybvig (1983); (iv) The existence of strategic complementarities in the decision-making of depositors.

whilst mitigating financial instability. Possible reform proposals have ranged from institutional reforms (as ex-ante measures) and specific governmental policy measures like deposit insurance (as ex-ante measure) or suspension-of-convertibility (as ex-post measure).

Institutional reforms concern the re-designing of the features of a bank's balance sheet, so that, it no longer faces the dangers of financial instability. If, through demand deposit contracts, banks become fragile once they face large premature withdrawals, one important remedy would be to try to match the bank's structural features to the statistical predictability of the time pattern of withdrawals. The concept of 'narrow banking' does exactly that. With narrow banks, the maturity structure of assets are perfectly matched with the maturity structure of deposit contracts. Thus, the amount that the bank earmarks to the short liquid asset (e.g its reserves), is sufficient enough to meet payments to depositors, should they all decide to withdraw early. This form of institutional arrangement can help to prevent bank runs, but it does not achieve the optimal risk-sharing allocation. As Wallace (1988, 1996) argues and quoted by Freixas and Rochet (1997), the solution to the optimisation problem for the narrow bank is even dominated by that of autarky or that of a bank engaged in maturity transformation.

Government regulatory response may take the form of deposit insurance schemes or suspension-of-convertibility. Deposit insurance basically concerns the scheme designed to protect the interests of depositors, in the face of bank runs. Depositors are too small and diverse to be able to monitor the performance of bank managers. Furthermore, they may face high monitoring costs. This means that, left on their own, there will be an incentive for depositors to free-ride on each other's attempt to monitor. The resulting underestimation of monitoring, means that there must be some agency to look after depositors' interests, in case of bank failures. There are still questions in the literature surrounding the design of the most appropriate deposit insurance scheme[8]. Suspension-of-Convertibility (SOC)[9] concerns the formal prohibition of the bank to serve more than a certain threshold of proportion of early withdrawals. By preventing the long asset from being liquidated or traded, it guarantees that a certain amount is still available for payment in the final period.

The effectiveness of deposit insurance and SOC depend crucially on whether there are aggregate risks (about the aggregate proportion of early withdrawals) or not in the setup. In the absence of aggregate uncertainty, they achieve the same results: they both eliminate the possibility of having bank runs and help maintain the optimum outcome. With aggregate uncertainty, the equivalence between the two schemes break down. SOC still eliminates bank runs, but it is not efficient as a risk-sharing instrument. The reason is that, with uncertainty about the pattern of aggregate withdrawals, there may be either of the following two scenarios: if the proportion of early withdrawals is too high compared to the threshold for SOC, those withdrawing early will be rationed and get a smaller amount than has been promised. If it is

[8] For instance, how should the system be financed? how to mitigate the adverse impact of deposit insurance of depositors' incentive to monitor? should the insurance scheme be partial or full?

too low, it means that those deciding to withdraw in period 2, are too numerous, and again, will receive less than has been promised. In other words, SOC does not allow for contingent allocation. Deposit insurance, on the other hand, makes allocations contingent on aggregate shocks. In the special case in which the deposit insurance scheme is publicly run and financed by an appropriate tax system, the government can vary the tax rate based on actual realisation of early withdrawals, and achieve the optimal risk-sharing allocation. The actual results are subsumed in Table 2:

Table 2: Policy Implications - Summary

	Specific nature of reforms	**Eliminate bank runs?**	**Achieves first-best (risk-sharing) allocation?**
Institutional Reforms	Narrow Banking	Yes	No
Contractual Reforms	➢ Equity contracts? (Jacklin, 1987), (Jacklin-Bhattacharya, 1988) ➢ Make contracts more flexible? (Peck-Shell, 2000)		
Policy Measures **(No Aggregate Uncertainty)**			
Suspension-of-Convertibility (SOC)		Yes	Yes
Deposit Insurance		Yes	Yes
Policy Measures **(Aggregate Uncertainty)**			
Suspension-of-Convertibility (SOC)		Yes	No
Deposit Insurance		Yes	Yes

2.3 Robustness of Liquidity Insurance Models

Thus, demand deposit contracts are seen to achieve optimal risk-sharing, but are also see to be unstable. The natural question that comes to mind is: why are deposit contracts then issued by banks? Since Diamond and Dybvig (1983), the literature on bank runs has evolved and many different avenues have been explored in a way that literally helps to answer this question from different perspectives. Jacklin (1987), for instance, argued that equity contracts can sometimes do better than demand deposit contracts for certain specification of utility function. In this model, consumers are equity holders rather than depositors in the bank. Whilst achieving the same (optimal) consumption allocation as a deposit contract, these equity contracts are not susceptible to bank runs. The rationale is that equity contracts are *coalitionally incentive compatible (i.e* immune to withdrawals by coalitions of individuals) while deposit contracts are only *individually incentive compatible* . For more general specifications of utilities, deposit contracts dominate equity contracts, thereby unearthing the inverse relationship between efficiency and stability again. Other papers have endeavoured to rationalise the case for actual contracts taking the form

[9] This is the equivalent of a standstills arrangement in international finance.

of demand deposit contracts with the possibility of withdrawals on demand, rather than some other form (See Calomiris and Kahn[10] (1991) and Diamond and Rajan[11] (2001)).

A trend of the literature on bank runs has also considered the " other view" of bank runs and have related the performance of the bank's assets to the business cycle. These models allow the return on the long technology to be stochastic. This second view reflects empirical studies by Gorton (1988), Calomiris and Gorton (1991), which show that bank runs are not random events but intimately related to the business cycle. These models have important policy implications that help add new dimension into our thinking as to how policymakers should effectively conduct policy.

Allen and Gale[12] (1998) confirm the findings of studies by Gorton et al, by showing that the business cycle plays an important role in triggering banking crises. In a model in which the long technology is subject to stochastic returns and cannot be liquidated early, they show that bank runs are optimal in that they help achieve first-best optimal risk-sharing! Banks achieve the optimal outcome through offering fixed deposit contracts, with bank runs providing the optimal contingencies that help achieve first best result. Thus, according to Allen and Gale (1998), it does not make sense for governments to regulate the banking industry!

Another paper which relates banking performance to business cycles is the one by Goldstein and Pauzner (2000). One of the setbacks of the Diamond and Dybvig (1983) framework, is that there is nothing within the model to explain what exactly triggers bank runs and coordination failure problems. The collection action problem means that each depositor is better off withdrawing conditional on other depositors withdrawing, even though, collectively, they would be better off if they did not withdraw. What drives these beliefs is not within the realm of the model and can be attributed to extraneous variables like sunspot phenomenon. Hellwig (2002) and Morris and Shin (1998) attribute this indeterminacy to two elements: common knowledge of fundamentals and higher order beliefs certainty. Goldstein and Pauzner (2000) are able to pin down unique equilibrium in models involving bank runs, using the global games approach. They find the endogenous probability of bank run occurrence and relate it to the demand deposit contract. By trading off benefits of risk-sharing vis-à-vis the probability of bank runs, they characterise the optimal contract and show that it does not achieve first best. By getting rid of the

[10] In the model, there is aggregate uncertainty and moral hazard. The bank is a monopolist and depositors only withdraw in period 2. Whenever banks act opportunistically, asset returns go down. By being given the possibility of withdrawing on demand, depositors who observe low asset returns can withdraw- thus, mitigating any attempt for the bank to act opportunistically. In the special case of banks having superior information about their own activities, there is an incentive for depositors to monitor.

[11] Diamond and Rajan (2001) have arguments which are similar to Calomiris and Kahn (1991) but differ in that they pay more explicit attention to the nature of a bank's illiquidity. Entrepreneurs have special skills in generating returns for investment projects. Thus, putting the project into different hands will reduce the returns of the investment. As such, these projects are viewed as illiquid. By developing relationship with these entrepreneurs, banks are able to learn these skills and may even use them to their own advantage. Deposit contracts prevent them from so-doing through a mechanism, similar to Calomiris and Kahn (1991).

[12] We consider this model more explicitly later.

indeterminacy inherent in Diamond and Dybvig (1983), they argue that it is technically possible to compute the effectiveness of alternative policy measures. In other words, if the model is no longer silent about the probability of bank runs, it becomes convenient to estimate how successful different policy measures will be to pre-empt these runs.

Zhu (2001) develops a two-stage banking model, in the same spirit as Goldstein and Pauzner (2000) and, attempts to examine the welfare properties of policy mitigation. He finds that SOC is both ex-ante and ex-post inefficient in preventing bank runs because it cannot distinguish between those with true liquidity needs and those who are simply running on the bank. Thus, even if bank runs are prevented, it is likely that some agents facing true liquidity needs cannot withdraw their deposits, while those without true liquidity needs get their money back. Deposit insurance is ex-post efficient in preventing bank runs but ex-ante inefficient, due to moral hazard reasons. Because the deposit insurance authority cannot monitor bank's decision, banks have an incentive to behave opportunistically. The paper suggests that replacing full-coverage deposit insurance by interest-cap deposit insurance[13], can overcome the moral hazard problem and help the economy achieve socially optimal outcome. The imposition of capital requirements is an efficient way to prevent bank runs. As capital requirements increase, the market equilibrium converges to the socially optimum outcome.

Another trend has included moral hazard in models of bank runs. Since the work of Calomiris and Kahn (1991), in a setup that includes moral hazard and aggregate uncertainty, several papers have attempted to include moral hazard considerations in bank run models and explore the properties. Cooper and Ross (1998) attempt to examine the trade-off between risk sharing and moral hazard associated with the design of banking regulations. They show how regulatory instruments (like deposit insurance and capital requirements) can be used to control bank runs in an environment in which banks can act opportunistically by making imprudent investments and depositors can monitor the bank. Their paper is a synergy of similar work in the literature, including Matutes and Vives (1996), Besanko and Kanatas (1993), Holmstrom and Tirole (1993). The main policy implications of Cooper and Ross (1998) setup are, as follows: in the Diamond and Dybvig setup (1983), publicly financed deposit insurance can be effective as protection against expectations-driven bank runs. But moral hazard considerations are ignored. Deposit insurance avoids bank runs but has a two-pronged impact on incentives: on one hand, depositors are not willing to monitor the banks' performance and, on the other, bank managers are willing to act opportunistically in order to maximise the option value of the deposit insurance. By taking this moral hazard consideration into account, they characterise the trade-off that helps derive the optimal degree of deposit insurance. Complete deposit insurance is not sufficient to support the first best outcome, because depositors will not have adequate incentives for monitoring. This outcome can nonetheless be reached through a combination of policies. Capital requirements, when coupled with

[13] Zhu (2001) argues that two variants of deposit insurance can be considered to mitigate the adverse effect of moral hazard that results from full coverage deposit insurance: a limited-coverage deposit insurance and coinsurance. The former protects the principal and interest of depositors up to a certain limit. The coinsurance system specifies that only a proportion of deposits

partial deposit insurance, can eliminate this incentive problem and help achieve the first best allocation again.

SECTION B: FINANCIAL CRISIS PROPAGATORS

3. Models with Multiple Financial Intermediaries

3.1 Introduction to Section

Several episodes of financial crises are characterised by financial contagion among banks. The term financial contagion is taken here to mean, in broad terms, the spread of a banking crisis from one bank to another. The spread of a financial crisis from one bank to another can be through several channels. Contagious bank failures can be the result of either informational spillovers or contractual arrangements that connect banks or common exposure to some fundamental.

Informational externalities arise when depositors perceive the banks to be similarly affected, even though there may be no direct form of contracts that connect banks. Thus, depositors at one bank view the event taking place at another bank, and update their beliefs about their own bank, so that their bank shares the same fate as the first bank.

Contractual arrangements may take the form of direct links such as interbank market in deposits or loans or may take less explicit direct form links (e.g through asset prices or through the settlement/payment system). In the former case, banks engage in cross-holdings of interbank deposits as a way of insuring against regional liquidity shocks. When one region suffers a banking crisis, the other regions suffer a loss because their claims in the troubled region fall in value. If the spillover effect is strong enough, it can cause trouble to banks in adjacent regions. In the worst case scenario, the trouble may spread from bank to bank and, may indiscriminately, affect all banks in the economy. In the latter case, when there is excess demand for liquidity, banks liquidate their long assets and this drives asset prices down. This drop in prices cause some banks to go bankrupt and this leads to further sales and further price drops. Bankruptcy spreads through the market for long asset. If the magnitude of asset price fall is large, this may prompt a chain of multiple bank insolvencies. Even, if the initial shock is small, the spillover effects through banks, may be cumulative and strong enough to warrant multiple bank failures.

(including interest) are protected. In the model, the interest-cap deposit insurance is the same as the limited-coverage deposit insurance scheme because agents are homogenous.

Common exposures take the form of two banks being similarly and symmetrically exposed to the same fundamental. Hence, a change in the fundamental value will affect both banks, thereby prompting some form of ex-post correlation in their underlying asset.

The concept of financial contagion has important implications for public policy activities of central banks as part of their crisis prevention and crisis management activities. More importantly, the multiple-bank setting involves aspects that spread beyond the confines of individual banks and that enable us summarise the resulting implications for central bank policy as follows:

- What is the nature of the dividing line between *microprudential* and *macroprudential* policy measures ?
- How effective are public policies at making the financial system more robust?
- How should central banks design the network structure underpinning financial systems in a way that best makes the financial system resilient to shocks?

The sources of market failures responsible for transmitting a risk contagiously from bank to bank lie directly in the mechanism connecting the banks. Whilst this mechanism is responsible for channelling liquidity from liquidity-abundant banks to liquidity-strapped banks, it is also the channel through which trouble spreads in times of difficulties. Thus, the market failures directly responsible for spreading contagious risks are the externalities (and different forms they assume) that various channels create at times of trouble. It is important to note that, in this section, we will not be focusing on how market failures, per se, prevent the efficient workings of the various channels. This will be the focus of the next section.

3.2 Models with Overlapping Network Connections or 'Direct Links'

Allen and Gale (2000) study a multiple bank version of Diamond and Dybvig (1983), in which banks are connected by an overlapping network of interbank deposit claims. The economy consists of a number of regions. The number of early and late consumers (who are assumed to have complete information about their environment) in each region fluctuates randomly, but the demand for aggregate liquidity is fixed. This opens the way for inter-regional insurance as regions with liquidity surpluses provide liquidity to regions experiencing liquidity shortages. The implication of constant aggregate demand for liquidity, is that regional liquidity shocks are negatively correlated across regions. While, in the interim period, some banks face excess demand for liquidity, others face excess supply of liquidity. In the subsequent period, the patterns for liquidity demands are reversed. One possible way of insuring against regional liquidity shocks is to engage in an ex-ante cross-holding of deposits through the interbank market. The interbank market is one way of implementing risk-sharing among banks.

While cross-holding of deposits are useful for reallocating liquidity within the banking system, they cannot increase the total amount of liquidity. If the total demand from consumers is greater than the stock of the short asset, the only way to meet this excess demand, is to liquidate the long asset. Allen and Gale (2000) show that, based on cost considerations, banks prefer to liquidate the short asset first, then their holdings of deposits in other banks and, lastly, their long asset. With the presence of an unanticipated aggregate liquidity shock (this condition has been shown to be necessary and sufficient for the analysis of financial contagion in the model), banks facing excess demand for liquidity, are forced to claim back their deposits held in other banks. If the amount received is small, the bank will be forced to liquidate its long asset to meet excess demand for liquidity. If doing so means violating incentive compatibility constraint (which technically makes returns to second period withdrawals higher than returns to first period withdrawals), there is a run on that bank and it may be forced into bankruptcy. Such an event reduces the equilibrium value of claims on that bank. Thus, other banks that hold deposits in it, will suffer a fall in their asset value. They may suffer from the same fate if this fall in asset value (i.e the spillover effect) is large.

Whether contagion occurs or not depends on the pattern of interconnectedness that shapes the interbank market structure. Allen and Gale (2000) assert the existence of three possible types of networks connecting banks: complete, incomplete or disconnected. A 'complete' network is one in which each bank holds claims on all other banks. An 'incomplete' interbank market is one in which banks hold deposits at banks in the adjacent region only. A 'disconnected' structure is one in which there may be no direct links between banks.

The incomplete interbank market is more susceptible to contagious effects than a complete interbank network. A complete network would ensure that the spillover effects of bank failure in one region evenly spreads out to all banks in other regions. Thus, a given size of unpredictable aggregate liquidity shock, is distributed uniformly across all banks. The greater the number of banks, the more spread out the spillover effects will be, and the greater will be the ability of the banks to meet uncertain liquidity shocks, without prompting bank runs. An incomplete network achieves the opposite results. The spillover effect becomes larger as the crisis spreads from one bank to another. The larger the number of banks, the larger will be the spillover effects. Contagion will inevitably occur in this realm. If banks are disconnected, the spillover effect is thwarted and does not affect the value of claims in other banks. No contagion occurs.

3.2.1 Robustness of Financial Contagion Models with 'Direct Links' and Policy Implications

Various attempts to test the robustness of the Allen and Gale (2000) model, with varying degrees of success. Dasgupta (2002) uses the global games approach to study a two-bank version of contagion. In his setup, banks invest in a long term technology that yields a stochastic return (i.e one that is dependent on some independently and identically distributed fundamental). Depositors are assumed to observe the idiosyncratic fundamental of their bank with some noise and the timing in terms of decision-making is assumed to be structured and dynamic: depositors at one bank make their decisions before depositors of the other. In addition, in period 1, the banks face a regional liquidity shock that is negatively correlated across banks. In the spirit of Allen and Gale (2000), banks cross-hold a fraction of their deposits, in period 0, as a way of insuring against these regional shocks. Thus, given the realisation of the regional liquidity shock, the bank facing high withdrawals will claim back its deposits from the bank facing low withdrawals. Thus, there is a spillover effect in that, the value of one bank's deposits in the other bank depends on the financial performance of the other bank[14]. As in Allen and Gale (2000), this provides the mechanism that propagates a crisis from one bank to the other.

Exposure through the interbank market means that, while the degree of regional insurance against liquidity shocks is higher, the possibility of having contagious flows is also higher. The intensity of contagion increases with the size of interbank connections, provided by the ex-ante cross holdings of deposits. Tables 3 and 4 highlight the main lines of contrast between Dasgupta (2002) and Allen and Gale (2000) as well as Dasgupta (2002) and Goldtsein and Pauzner (2003).

Table 3 – Dasgupta (2002) v/s Allen and Gale (2000)

(Both models assume several banks connected through the interbank market in deposits)

Allen and Gale (2000)	Dasgupta (2002)
Banking panics occur due to Aggregate liquidity shocks (necessary and sufficient conditions for Contagion to occur)	No Aggregate liquidity shocks required for Contagion. The only requirement is adverse information about asset returns
Financial Contagion occurs with zero probability	Financial Contagion occurs with positive probability (endogenously derived)
Network architecture matters – Contagion is a function of the pattern of connectedness of banks in the interbank market. - Complete network : No contagion	Network architecture is irrelevant - Contagion occurs with positive probability, even with complete network structure in the interbank market

[14] Dasgupta (2002) uses the concepts of 'debtor bank' and 'creditor bank' to refer more specifically to which bank experiences the regional shock first.

- Incomplete network: Contagion occurs	

Table 4 - Dasgupta (2002) vs Goldstein and Pauzner (2003)

Goldstein and Pauzner (2003)	Dasgupta (2002)
One Bank	Several Banks connected through the interbank market in deposits
Optimal Contract for deposits: Characterised by trade-off between risk-sharing and positive probability of bank runs (contracts offering better insurance also increase likelihood of runs)	Optimal Contract for Interbank deposits: Characterised by trade-off between insurance against liquidity shocks and positive probability of contagion
Result: Optimal contract offers less than full risk-sharing because doing so would be too destabilising	Result: Optimal interbank deposit contract offers less than perfect insurance against regional liquidity shocks

Dasgupta (2002) model shows, that for contagion to exist as an equilibrium phenomenon, it is not necessary to have unanticipated liquidity shocks. This goes against the philosophy of Allen and Gale (2000). Furthermore, it shows that, with the interbank market providing ex-ante liquidity insurance against regional shocks, the structure of connections, spanned by the interbank market, does not matter. Even with complete markets, contagion may still occur as an equilibrium event.

Nonetheless, it will be interesting to point out how the two models vary in terms of their implications for welfare and use of policy for mitigating contagious risks. As ex-ante measures, Allen and Gale (2000) suggest the reform of the network architecture connecting banks. Since the complete network is more robust at mitigating the spillover effect than the incomplete network, it is highly suggestive for policymakers to ensure that the structure of overlapping interbank claims is as complete as possible. By preventing contagion, the appropriate design of the network system guarantees that the first-best allocation is reached. A similar conclusion is reached by Freixas, Parigi and Rochet (2000). In this model, the source of uncertainty is assumed to be 'location shocks' i.e ex-ante, depositors are unaware as to where they should consume. It is only in the interim period (i.e period 1) that they will know the nature of this location shock. Decisions to withdraw are made in period 2. The network connecting banks depends very much on the pattern of travel. There are two travel patterns in the setup: a '*credit chain lending'* pattern and a '*diversified lending'* pattern. The paper also investigates the robustness of the different types of travel patterns to the possibility of contagion. The diversified lending pattern is shown to be more robust and less susceptible to contagious effects than the credit chain pattern. With a

credit chain pattern, the credit risk is concentrated on a few banks only. Thus, while a few banks take the hit, the effect at individual bank level may be strong enough to warrant closure of next bank. With diversified structure, the credit risks are more evenly spread across banks. When the number of banks is large, it is completely diversified so that no contagion exists.

In Allen and Gale (2000), the standard one policy tools, that can restore first-best in the one bank case, will work. But the timing and implications of central bank intervention will depend crucially on the interbank market structure, as discussed above, connecting banks.

Only in the special case of an incomplete network, will policy intervention be necessary. Because the origin of the banking panic transmission is an initial liquidity shock at one bank, it follows that ex-post measures (such as suspension of convertibility) at that bank, will help. The main point is that what creates the channel for spreading a crisis across banks, is interbank balance sheet connection. As long as the crisis is prevented where it started, the links between banks will not be affected and the balance sheets of all banks will be preserved. Thus, these policy measures do not create an externality of their own, on other banks. All arguments regarding policy measures, in terms of efficiency, will all go through. Contagion will be prevented (since none of the banks' claims are affected).

The concept of Lender-of-Last-Resort (LOLR) can also be enunciated. LOLR is typically carried out when there are informational asymmetries, such that a bank experiencing temporary liquidity problem, can become insolvent or when an illiquidity problem can spread from bank to bank, amplifying all along the way, until it becomes degenerate. Since the Allen and Gale (2000) framework deals overwhelmingly with assessing channels that connect banks constitute the main externalities during times of troubles, it is obvious that LOLR, in such models, should be viewed more from (2), rather than (1). By providing emergency funding to banks facing illiquidity problems, LOLR ensures that there is no need for the bank to liquidate its long asset – which prevents the value of claims that other banks hold in it to fall. Thus the spillover effect is thwarted.

It is important to note that agents in the Allen and Gale (2000) setup, have complete information about their operating environment. In real world though, the analysis of LOLR, is conducted in an environment in which the central bank has incomplete information about the liquidity and solvency positions of banks. In this case, it will be optimal for the central bank to intervene if doing so entails benefits (in terms of preventing multiple collapse) that outweigh the costs (in terms of taxpayers' money), so that, from a more generalised perspective, it is welfare improving, from society's point, to do so.

Not many papers adopt the same perspective. Rochet and Tirole (1996) argue that, in a multiple bank setting, contagion may be good and no policy intervention whatsoever is needed, because it helps promote peer monitoring among banks and achieves market discipline. They study a system in which ex-post lending may be allowed to mitigate systemic risk, while still preserving the benefits of ex-ante monitoring. If no monitoring is allowed, then bank managers have an incentive to act opportunistically and undertake activities that may not necessarily be in the interest of other stakeholders. To prevent this behaviour which leads to moral hazard, some form of monitoring technology is used.

In the Rochet and Tirole (1996) model, banks face heterogenous liquidity shocks. Those that cannot raise liquidity are forced to stop their projects and go bankrupt. To prevent this, banks with excess liquidity can lend to banks facing liquidity shortage and monitor the borrowing banks, provided the costs of so-doing, are not too high. Under incentive-compatible interbank lending, the performance of the lending bank must be dependent on the performance of the borrowing bank, but not vice versa. Only under this condition, will the lending bank have an incentive to monitor the borrowing bank. This suggests that, sometimes, it may be good to close down a solvent bank with exposures to illiquid bank. It may be good to allow contagious effects resulting from bank failures to spur optimal monitoring. An optimal public policy will present a trade off between the benefits of allowing contagious effects (e.g greater monitoring and market discipline) against the costs of so-doing.

3.3 Models with Informational Spillovers

Models with informational spillovers mainly focus on the spread of a crisis from one bank to another, in a setup in which the banks' fundamentals are believed to be correlated. There is no direct link connecting the banks, in the form of contractual arrangements such as interbank market in deposits and loans. Nonetheless, the underlying fundamentals are perceived to be correlated, in a way that invites correlation in payoffs of depositors of both banks. Hence events at one bank provide information to depositors of other banks and the failure of one bank leads depositors of the other bank to adjust their expectations in such a way that their bank suffers from the same fate as the first bank.

Chen (1999) studies a multiple bank setup in which the existence of demand deposit contracts coupled with informational spillovers, leads to some form of strategic complementarity and hence create conditions for contagious banking crises. Banks basically invest in risky assets, with the returns to risky asset, being positively correlated across banks. In each bank, a fraction of patient depositors observe the return to the risky asset perfectly. In addition, these depositors do not observe their signals at the same time: depositors of a subset of banks move first (i.e take their decision first) and then, depositors in the remaining banks act. Depositors in the latter group are assumed to noisily observe the number of bank failures in the first group of banks. They may run on their own banks, even before observing their signals about their own banks' project realisations.

Chen (1999) goes on to show that, given demand deposit contracts, there exists a critical threshold in the number of failures among the first mover bank. If the actual number exceeds the critical threshold, then all depositors in the remaining banks will run on their banks. The specific features of the contract are also analysed. The optimal deposit contract is influenced by any possibility of bank panic. Bank panics become more likely, the higher the prior probability about the state of the economy being bad and the higher the period 1 (i.e interim period) deposit payment.

3.3.1 Robustness of Informational Spillover Models and Policy Implications

Chen's model highlights an important attribute of models involving contagion from informational spillover effects: that information transparency is important in mitigating the spread of crises. The same can be said about Dasgupta (2002). By increasing the precision of signals and coordinating beliefs on the proper outcome, the 'contagion spread' can be minimised, thereby mitigating the onset of a crisis spread. Archarya and Yorulmazer (2003) reach a similar conclusion. They extend the informational spillover approach by constructing a model of systemic risk involving banks, with informational contagion existing on banks' liabilities side, and bank loan correlations existing on the asset side. The interaction between the two enables them study the ex-post and ex-ante aspects of systemic risk. In their model, the return to bank loans has two components: a systematic component and an idiosyncratic component. Depositors can observe the overall realisation of bank loan returns, but not the actual decomposition. So, when one bank fails, depositors of the other bank think that signals send bad news about the overall performance of the economy, and use Bayes rule to update their priors. The rate of return on deposits (or borrowing) to staying in the second bank, is adjusted in such a way that it shares a similar fate to the first bank. To mitigate this informational spillover resulting from one bank's events on another bank's borrowing costs, both banks engage in ex-ante herding (i.e endogenously choose correlated portfolios) in order to maximise the possibility of joint survival. The model has policy implications that share similar tenets to those of Chen (1999): as long as a policy instrument succeeds to make the interest rate on deposits (or borrowing) insensitive to bank events, no informational spillover occurs and the ex-post cost of mitigating contagion will be minimised. Informational transparency would, for example, make the distinction clear between the systematic and the idiosyncratic component of bank loan returns. If depositors of the second bank know that the bad performance of the first bank has been due to idiosyncratic poor performance of loans of the first bank and not due to overall bad performance, then they will not be tempted to run on their own bank. Thus, no informational spillover results.

Other approaches in the literature consider the interaction between informational spillover effects and aggregate liquidity position: Aghion, Bolton and Dewatripont (2000) show how, in the presence of imperfect information about banks' liquidity[15], a liquidity problem at one solvent individual bank

[15] Chen (1999) considered the case when there was imperfect information on banks' solvency.

level, may have widespread contagious effects. If banks are subject to uncertainty in the timing of realisations of their long asset returns, a liquidity shock could lead to a high proportion of cash-strapped banks (banks that are faced with the prospects of delayed returns and high short term deposit withdrawals) relative to cash-abundant banks (banks that are faced with the prospects of immediate returns realisations and low short term deposit withdrawals). If the cash-abundant banks can service the cash-strapped banks through the interbank market, there is no need for public policy intervention. Should the amount required be beyond the reach of cash-abundant banks altogether, then there will be aggregate liquidity shortage, with some cash-strapped banks being rationed (the interbank lending rate is fixed) whereas others are forced to liquidate their long assets. By observing other bank failures, depositors think that this may be due to aggregate liquidity shortage. Fearing the worse about their own bank, they withdraw. The inability of the interbank market to function effectively means that the desire for public policy intervention is called for. In a similar spirit of thought, Diamond and Rajan (2001b) consider how, through an interplay between illiquidity and insolvency, an aggregate liquidity shortage leads to contagion. Their paper is closely related to Aghion, Bolton and Dewatripont (2000), but stresses that banks facing liquidity problems usually try to issue new deposits to bridge the liquidity gap. To do so, they must raise interest on deposits. This reduces the value of bank assets and leads to insolvencies.

Policy implications have similar traits to those of informational spillover models of Chen (1999) and Archarya and Yorulmazer (2003). Increased transparency will enable depositors make difference between aggregate liquidity stance and their own bank's liquidity position. As a result, they will be able to make more reasonable judgements about their own bank's position. Injection of liquidity into the system can be carried out, but there are questions that will inevitably prop up as to whether the liquidity injection should be applicable to cash-strapped banks only. Aghion, Bolton and Dewatripont (2000) investigate the costs and benefits of having an unregulated banking system. While the absence of public safety nets provides incentives for peer monitoring and eliminates moral hazard among banks, it also fails to block the channel through which aggregate liquidity shocks are channelled throughout the banking system. This brings questions about what the optimal public safety net should be.

How about standard central bank policy measures ? An interesting contradiction with the models of contagion based on direct links as above, is that here, the expectations of depositors are explicitly modelled. Thus, the effectiveness of policy measures administered at the bank experiencing the initial shock, will depend crucially on how depositors react to these policy measures. Generally, such measures applied to the initial bank, will create an externality (positive or negative) on other banks. As such, policy measures, by themselves, may create a distortion between privately optimal and socially optimal outcomes and beg in questions as to whether these measures should not be more 'general' (i.e applied to those banks that are considered to be most vulnerable to informational spillover effects, rather than to banks that experience the liquidity shock in the first instance).

3.4 Models with Asset Price Changes

Amongst others, Schnabel and Shin (2003), find evidence of high asset price correlation for different assets in Europe, during times of financial distress. The obvious explanation is aggregate liquidity shortage. Cifuentes, Ferrucci and Shin (2003) show that, with a pattern of interconnectedness generated by a rich structure of cross-holdings, coupled with the existence of regulatory solvency constraints, the demand for illiquid assets is less than perfectly elastic, so that asset sales to meet liquidity demands by institutions will largely depress asset prices. Many studies carried out find evidence for an asset price channel, as potential explanation of a spread of a crisis from one bank to another. The determination of asset prices, in equilibrium, will depend on the availability of liquidity in the system[16]. If banks have access to efficient markets for liquidity provision, then there will be no need to liquidate assets, and, asset prices will not be affected. In the event in which illiquid banks are forced to liquidate their assets in order to meet demand for liquidity, the price of such assets may fall – thereby affecting the value of portfolios of all banks in the financial system. We shall refer more explicitly as to why the prices fall during liquidation and what corrective mechanisms may be taken to mitigate asset price changes in the next section. The main policy implications for this section are subsumed in table 5, as follows:

Table 5: Models with Multiple Banks

	Ex-ante policy measures	**Ex-post policy measures**
Interbank network connections (through balance sheet)	Design of network structure connecting banks matters	(only in incomplete network structure): Policy measures taken at bank experiencing the liquidity shock (same as one-bank setting): No need to take account of spillover effects that policy measures will present to other banks
Informational Spillovers	Increased transparency for more informed judgement	Policy measures taken at bank experiencing the liquidity shock : there is a need to take account of spillover effects that policy measures will present to other banks

[16] We shall refer more explicitly to the relationship between liquidity supply and asset prices in the next section, when we integrate models of financial intermediaries with models of financial markets.

4. Models of Financial Intermediaries and Financial Markets

4.1 Introduction

Banks facing illiquidity problems usually have recourse to financial markets or to the interbank market in order to alleviate their temporary illiquidity problems. It is the purpose of this section to consider what market failures may inhibit the smooth operation of the financial market or the interbank market, thereby preventing banks from getting access to much needed funding, and explore what policy measures may help restore the efficient operations of the markets. Denial of funding in times of trouble may lead to insolvencies, with system-wide implications.

Till now, as far as '*homogeneous banks*' are concerned, we have kept financial intermediaries and financial markets as separate from each other. A bank can use financial markets in three main ways:

- It can use financial markets as a way of insuring against aggregate risks – here, risks are taken to mean uncertainty about the distribution of early withdrawals or uncertainty about the realisation of investment returns in the long technology
- It can use financial markets to trade the long asset. The illiquid asset may thus be liquidated in order to meet liquidity demands that cannot be met from the short asset alone;
- It can use financial markets as a basis to issue claims against the long asset.

Integrating financial intermediaries and financial markets in a micro based model has important implications for systemic risk and financial fragility. Gale (2004) argues that introducing these markets into models of financial intermediaries, has important implications for the welfare properties of the model: on one hand side, bankruptcy involves no inefficiency ex-post – firesale prices simply represent transfers rather than deadweight losses. On the other hand side, ex-ante risk sharing is optimal if there exists a complete set of Arrow securities for hedging against these aggregate risks.

Banks, so far, have been assumed to liquidate their assets through some exogenous technology, with the price of the asset and the supply of liquidity, being taken as given. This is a rather strong assumption. By trading their assets, the price at which the asset is traded, is not longer exogenous, but rather, set by equilibrium forces of demand and supply in the bond market. This provides important insights into analysis of asset price volatility and endogenous liquidity provision. In the presence of market failures such as incomplete markets for hedging against aggregate uncertainty or incomplete

trading opportunities, a bank's interaction with the financial market, may lead to excess price volatility for the asset, in such a way that this jeopardises the ability of the bank to meet liquidity demands and fulfil contractual obligations. This provides important insights into the phenomenon of financial fragility i.e a situation in which small shocks can have wide impact on the financial system. The weakest link in this interplay between banks and financial markets is often the crucial role of liquidity in the determination of asset prices. In the presence of incomplete markets and aggregate uncertainty, financial intermediaries are forced to sell assets in order to obtain liquidity. But since holding liquidity involves an opportunity cost, the suppliers of liquidity can only recoup this cost by buying assets at resale prices in some states of the world – this private provision of liquidity by financial markets is always inadequate to ensure complete asset price stability – which therefore reflects failure of the market mechanism to allocate resources efficiently to the banking system and calls forth, the need for public policy intervention.

'Heterogenous banks' may engage in the interbank market, through ex-post interbank lending or ex-ante cross holding of deposits, as crisis prevention measure against liquidity shocks. The interbank market was covered in the previous section. However, we were then more concerned with the role of interbank market connections as representing possible externalities propagating a crisis from one bank to another. In this section, we shall not be concerned with how interbank market failures may spread a crisis across banks but rather, with what the different possible forms of interbank market failures are, and how to eliminate them. Goodfried and King (1998) argue that if the interbank market is efficient, then any solvent but illiquid bank will always get the funding it needs at times of difficulty. In that case, there would be no need for the central bank to intervene and its activity will be limited to monetary stability only.

In case of inefficiency though, a solvent bank facing temporary illiquidity problems may turn out to be insolvent if it does not receive adequate funding. Public policy interventions, such as lender-of-last-resort, would be highly desirable. Even if government intervention is justified in the presence of market failures, there remains key questions about the desirability of such policies and the particular forms they may take.

4.2 Asset Markets as Liquidity Providers – Homogenous Banks and Financial Markets

Donaldson (1992) develops a model in which the monopoly power of some banks may lead to significant underprovision of liquidity. Banks facing temporary illiquidity problem, sell securities or claims on their long illiquid assets. There are two sides of the market: institutions that demand liquidity (i.e cash-strapped banks) and suppliers of liquidity to the banks (i.e reserve agents). Banks issue these claims to reserve agents, with the price of these claims being determined by competition among reserve agents. When the demand for liquidity is low or no reserve agents enjoy market power, then the securities will trade at normal or fair prices. Conversely, if the demand for liquidity is high or there is

some form of monopoly power among reserve agents, these securities will trade at prices below their fair value. If the reserve agents are interpreted as banks that have excess liquidity, then their monopoly power depends on: their proportion relative to the total number of banks and the distribution of excess liquidity is more favourably biased towards some banks only, so that the other cash rich banks have resources that are not enough to meet total liquidity demand in the economy.

Suppose there is some exogenous productivity shock that affects a *fraction* of banks only: this shock causes the rate of return on illiquid assets to fall below the level promised to patient depositors, these depositors will start running on the bank. The latter will be forced to issue securities on its long asset in order to meet any excess demands for withdrawals. If the demand for liquidity is strong enough that it almost inevitably affects price of securities negatively, this makes it costly for *all* banks to obtain liquidity. Thus, technology shocks affecting liquidity position of some banks only have implications for asset prices of all banks, and, correspondingly may affect the solvency of other banks as well. Thus, financial contagion arises.

Allen and Gale (1998) extend the Diamond and Dybvig (1983) setup by considering complete illiquidity of the long asset technology and by making the return to the long technology stochastic, dependent on economic factors. By doing with the assumption of complete asset illiquidity, any form of panic-based bank runs, is eliminated. It also implements the optimal risk-sharing allocation, which is achieved by making consumption in the interim period (i.e period 1) dependent on the stochastic return of the long technology. From that perspective, bank runs can be seen to play an equilibrating role: Since there will always be something left for patient depositors to consume in period 2, early withdrawals by some patient depositors positively affects the payoff to period 2 withdrawals and lowers the return to period 1 withdrawals. Even though bank runs occur with positive probability, they are only partial i.e they involve only a fraction of late depositors withdrawing early (unlike Diamond-Dybvig (1983), which involves all late depositors withdrawing early). In the model, bank contracts together with the occurrence of bank runs, can be seen to provide the right contingencies, that allow the first best allocation to occur.

Allen and Gale (1998) then relax the assumption of complete illiquidity of the long asset by allowing for incomplete trading opportunities: the bank is allowed to trade securities through the issue of claims on the bank's long assets. This allows the endogenous determination of the long asset price and endogenous supply of liquidity to the bank. The deposit contract promises to pay a certain fixed amount to depositors wishing to withdraw early. If the amount provided does not suffice, the bank is forced to sell its long asset, so that those depositors who withdraw early, share the liquidation value of the bank. If the price at which the asset is trading in the financial market, is equal to its long term value, then, even with bank runs, the allocation is optimal. This price is, however, shown to be below its long term value, suggesting that the market underprovides liquidity when the bank is facing a run. There is a resulting redistribution of resources from depositors to potential buyers of assets or speculators.

While still satisfying the objectives of liquidity provision to the bank (though underprovided), financial markets break the possible advantages associated with bank runs as possible equilibrating mechanism because the optimal risk-sharing allocation is not achieved. On the other hand side, buyers of assets benefit greatly because they are able to buy the long asset for a price which is below the long term value.

4.2.1 Robustness of Models with Financial Markets and Policy Implications

For financial markets, one of the main points we focused on, was the fall in asset prices that results, following a desperate attempt by the bank to meet its contractual liquidity obligations. This asset price fall is intimately related to the supply of liquidity. In the case of incomplete markets, this supply may not be enough to ensure full asset price stability. In models involving monopoly power as principal source of market failure and liquidity underprovision, market structural features were also an important contributor. What is needed is a mechanism to prevent the price from falling when banks attempt to sell assets. Public policy intervention, in the form of central bank finance, could prove helpful here. If the Central bank provides a repurchase agreement (i.e one in which it buys the illiquid asset at its face price from the bank at the time the bank needs liquidity, and, sell it back to the bank at the same price later), could help. By preventing the asset price from falling, the central bank successfully achieves its twin goals of liquidity provision during times of financial distress and prevention of systemic risk.

In some cases, liquidity provision is seriously impeded by coordination failure problems. For example, it may be costly for cash-abundant banks to provide funding to cash-strapped banks. There may be incentives for each cash-abundant bank to free ride in provision of liquidity whenever the amount of liquidity demanded is beyond the reach of each individual member but within the reach of a fraction of cash-abundant banks. In all cases, as remniscent of models of coordination failure, there are multiple equilibria – with a 'good' equilibrium depicting adequate liquidity provision and a 'bad' equilibrium, depicting inadequate liquidity provision. This provides a clear case for a central bank to intervene so as to reorganise banks and coordinate beliefs on the right outcome.

In Donaldson's (1992) model, the monopoly power is higher the more concentrated the supply of liquidity is among a few banks only, and, within this category of cash-abundant banks, the more biased the distribution of liquidity is among a few banks. Banking regulation, in the form of a well articulated competition policy in the banking industry, may be helpful in eliminating this threat of monopoly abuse, although Donaldson (1992) does not make clear, what specific form this competition policy may take[17]. In cases in which the amount desired falls beyond the means of any individual bank, intervention in the form of lender-of-last resort, may be desirable.

[17] In many instances, the number of banks facing excess liquidity or liquidity shortages may be beyond the control of regulatory bodies. If banks are subject to uncertainty in timing of asset returns realisations, an aggregate liquidity shock to the system may

Allen and Gale (2004) build on their previous studies (Allen and Gale (1998), (2000)) to provide sufficient conditions for ensuring efficiency in markets, through properties similar to those related to the fundamental theorems of welfare economics. In a setup with financial intermediaries and financial markets, what justifies policy intervention, is simply whether markets for aggregate risks are complete or not. Rationalising the case for financial intermediaries based on limited participation of agents in markets for contingent commodities, they point out that allocation is '*incentive efficient*' if financial intermediaries issue complete contracts. In the case in which market for risk is complete but banks are restricted to using non-contingent deposit contracts, default introduces a degree of contingency that may be desirable from the point of view of optimal risk sharing. Far from being best avoided, financial crises are desirable in order to achieve '*constrained efficiency*' , but this does not imply a market failure. This means that there is no justification for regulation by public authorities. In order for regulation to be justified, it is imperative that markets are incomplete. As in standard theories of government regulation, it is first necessary to identify a market failure in order to analyse intervention. The argument of Allen and Gale (2004) can be summarised in the following table:

Table 6: Incentive Efficiency v/s Constrained Efficiency[18]

	Complete Markets **(No justification for Public Policy intervention + No market failure)**	**Incomplete Markets** **(Justification for Public Policy intervention + Existence of market failure)**
Complete Contracts	*Incentive-Efficiency* *(First-Best Solution)*	*Inefficiency*
Incomplete Contracts	*Constrained-Efficiency* *(Financial crises can be seen to provide the right contingencies that bring efficiency)*	*Inefficiency*

This approach was used by Gale (2004), in considering the optimal bank capital structure. Bank capital usually serves two purposes: it acts as a buffer against unexpected declines in bank asset values and it acts as a mechanism that discourages excess risk-taking behaviour from the part of bank managers. In the presence of deposit insurance, depositors have no incentive to monitor bank managers and the latter have an incentive to pursue a risk-reward strategy ('gamble for resurrection') in order to maximise the option value of the deposit insurance. Bank capital is required in order to check this possibility of moral hazard. Whether deposit insurance is a sufficient condition for justifying regulation of bank capital or not, is highly debatable. Hellman, Murdock and Stiglitz (2000) develop a model that allows for the effect of higher charter value and capital adequacy requirements on risk-taking incentives.

result in too few or too many banks facing excess liquidity demands. This cannot be solved by the interbank market (see Aghion, Bolton and Dewatripont (2000) for more details) and cannot be met by issuing new deposits (see Diamond and Rajan (2001b) for more details) because of the impact of raising deposits (through increased interest rates) on bank asset prices.

[18] Taken from Allen and Gale (2004), *Econometrica,* vol.72, No.4 (Jul 2004), pp 1025

Control of interest rates, together with capital adequacy requirements, are necessary to achieve a Pareto-efficient allocation of resources. These interest rate controls increase charter value and provide extra instrument for controlling risk taking. A Pareto improvement is possible even in the absence of deposit insurance.

This requires that the need to justify bank capital regulation, must ultimately beg down to market failures. If banks can fully internalise the full costs and benefits of capital requirements, then the privately optimal level of capital will coincide with the socially optimal level – then, there would be no need for policy intervention. For there to be a role for public policy regulation of bank capital, it must be shown that the capital requirement level chosen at one bank level imposes welfare-relevant pecuniary externalities on other banks.

In an Arrow-Debreu economy with complete markets, capital structure is irrelevant and the standard Modigliani-Miller theorem result holds. The privately optimal level of capital coincides with the socially optimal level and there is no justification for regulation. Complete markets act as a perfect substitute for capital. In the case in which markets are no longer complete, capital structure becomes determinate but the privately optimal level of capital still coincides with the socially optimal level. So, the case for public regulation of capital is again absent. In order to make a case for regulation, heterogeneity must be introduced among financial institutions, for example, banks facing different regional liquidity shocks. Efficiency would require cross-sectional (interbank) risk sharing, in which banks basically cross-insure each other against regional liquidity shocks. In the absence of complete markets, this efficient cross insurance cannot be attained. Thus, there is a case for public policy intervention.

Irwin, Saporta and Tanaka[19] (2005) extend the Allen and Gale (2004) setup, by considering a model of the financial system with heterogeneous banks and investment fund, within which financial crises can arise endogenously. Banks are subject to idiosyncratic and aggregate risks only whereas investment funds are subject to aggregate risks only. Banks and investment funds interact through financial markets but the authors assume that financial markets for trading assets are incomplete – which prevent the financial intermediaries from offering state-contingent contracts that can replicate complete markets outcome. In the paper, due to different risk appetite for investment fund customers and bank customers, investment funds can be seen as mechanisms that increase the welfare of banks by improving the risk-opportunities for the banks' customers. For high levels of risk aversion, banks face excessive risks but investment funds face too little risks. For low levels of risk aversion, the risk profiles are inversed across banks and investment funds. The consumption allocation does not match the (Pareto optimum) consumption allocation under a complete market – thereby leaving scope for welfare improving

[19] Many readers may view it more appropriate to include this paper in the next section where we consider the case of heterogeneous banks. However, by not causing any prejudice to our main classification scheme and headings and in tandem with the original line of thought discussed in this section, we have judged it more appropriate to include it in this section.

policies. The focus of the paper is on optimal policies that can be used to achieve the Pareto optimum consumption profile and to mitigate financial instability. Lump sum taxes and transfers between financial intermediaries can replicate the complete markets outcome for reasonable degrees of risk aversion, if they are contingent on the aggregate liquidity. Liquidity requirements, however, cannot achieve Pareto-efficient consumption allocation[20]. The intuition is steadfast: under reasonable ranges for risk aversion coefficient, banks face excess consumption risks whereas investment funds face too little risks. Increasing banks' holdings of liquid assets will reduce price volatility and expose bank customers to lower consumption risk, at the expense of decreasing expected utility of investment funds customers that would prefer more rather than less consumption risk. Thus, liquidity requirements cannot achieve the first-best outcome. The paper goes on to show how, regulation of one institution's liquidity position can lead to an inferior welfare outcome whereas regulation of both institutions' liquidity position can lead to a higher population-weighted utility.

Pagratis (2005) considers the interaction between liquidity requirements and LOLR, in a setup in which the central bank performs both, the LOLR activity as well as designing appropriate regulatory policy. Prudential liquidity regulation is considered to be a *quid pro quo* for emergency lending assistance by the central bank where prudential liquidity is considered to be an implicit insurance to banks in return for LOLR insurance. In the presence of funding constraints and possibility of information-based bank runs, the conditions under which liquidity requirements would be socially desirable, are examined. It follows that liquidity requirements serve as first line of defence against banks' liquidity problems that allow the central bank to maintain zero expected cost of LOLR intervention, while counteracting excessive risk-taking. Thus, the more debt-constrained the banking sector is, the higher profit opportunities are and the less stable the deposit base is, the more prudential liquidity regulation is regarded as socially desirable.

4.3 Asset Markets with Heterogeneous Banks - The Role of the Interbank Market

So far, we have been focusing our analysis, in this section, at the case in which one bank dealt with a financial market[21] and, how, that interaction may lead to financial fragility. The essence of the analysis would stay if we focused on homogeneous banks. In the presence of heterogeneous banks though, provision must be made to allow for the presence of the interbank market as a means of liquidity provision and liquidity shock insurance. As shown in the previous section, one possible way of interpreting the heterogeneity of banks, would be to allow for the presence of regional shocks that are negatively correlated across banks.

[20] This is in contrast to Allen and Gale (2004), where liquidity requirements can achieve the Pareto-efficient allocation under complete market. The point is that in Allen and Gale (2004), agents are ex-ante homogenous whereas in Saporta et al (2005), agents are ex-ante heterogenous.

[21] In the special case of Donaldson (1992), we sometimes referred to providers of liquidity in financial markets as "cash-abundant" banks. This is without loss of generality. The crucial point is that, since banks have been assumed to be homogeneous, it does not really make a difference as to what specific form this financial market may take.

The focus of this subsection, will be on the market imperfections that may impinge on the ability of the interbank market to channel resources efficiently among banks. If there is no aggregate uncertainty and no market imperfections plaguing the interbank market, there is nothing that prevents an efficient allocation, as Goodfried and King (1998) argued. Should any of these imperfections arise, the interbank market no longer provides perfect insurance and an illiquidity problem may turn into insolvency, with system-wide implications.

One source of market imperfection is informational asymmetry – banks in the interbank market may not lend to cash-strapped banks if they do not perfectly observe the composition of the borrowing banks' balance sheet or if the amount to be borrowed is too large compared to resources of the lending banks. This arises because this lack of observation makes it difficult to distinguish between a case of insolvency and a case of illiquidity. As a result, interbank market may be channelling loans to cash-strapped banks, against the promise of the banks' assets. But the banks may be willing to liquidate all bad loans ('non performing') from their portfolio, so as to keep the good ('performing') ones. The amount lent by the interbank market may not be sufficient to generate their value in the interbank market.

Bhattacharya and Gale (1987) develop a model in which informational asymmetry exists among banks, as regards each bank's asset composition and the size of liquidity shock that each bank faces. They show that, in the presence of such market imperfections, each bank will have an incentive to free-ride on the holding of liquid assets, since holding liquid assets is costly. The interbank market leads to underprovision of liquidity due to free-rider problems. They allow for interbank lending, in the absence of aggregate risk. The existence of the interbank market, is to allow banks to borrow and lend to each other. A banks' liquidity and investment needs are private information, observable to the bank alone. In equilibrium, both type of banks hold the same amount of reserves – the only uncertainty is about the need for liquidity to meet early withdrawals. Either type of bank may not truthfully reveal its type in the interbank market. If interbank rate is lower than the rate of return on illiquid asset, the optimal deviation is for both types of banks to borrow from the interbank market. Since holding liquid assets is costly and, under model parameters, the return on interbank loan is lower than that of long term investment, there will be liquidity shortages at the aggregate level, even in the presence of the interbank market. Banks will free-ride on each other for liquidity and underinvest in liquid assets.

Bhattacharya and Fulghieri (1994) extend the Bhattacharya and Gale (1987) paper, by allowing for uncertainty in the timing of short asset payoffs. While the long asset pays off only in period 2, the short asset may pay off in period 1 or 2. Thus, with some positive probability, it may not pay off in period 1 – in which case, banks holding it will face a liquidity shortage. The incentive-constrained second best solution requires that the return on interbank lending is higher than the return on the long term asset.

Thus, banks that have excess liquidity, will always be compensated for giving away that excess liquidity to cash strapped banks, through high interest rates. As a result, banks that have excess liquidity are profitable, despite the fact that holding liquid assets is costly. In equilibrium, banks may over or under-invest in the liquid asset.

Alger (1999) allows a multiple-bank setting, with the presence of credit risks, as market imperfections, in the interbank market for lending. The model is very identical to the Diamond-Dybvig (1983) framework, but with the added feature that the returns to the long technology is stochastic and the illiquid asset returns are correlated across banks. In addition, banks are subject to a probability of being solvent or insolvent, with this possibility of insolvency being independent of the liquidity shock realisation. The properties of interbank lending are analysed when banks have first best level of reserves, in the presence of credit risks. Following the realisation of liquidity and solvency shocks, there will be two types of banks: liquid and illiquid banks. A liquid bank that is insolvent will always lend to an illiquid bank, in a desperate attempt to maximise the option value associated with its assets. A solvent and liquid bank will only lend if credit risk is low and the probability that it gets paid back, is high. Thus, in the presence of a market imperfection in the form of a credit risk, the interbank market may fail to allocate resources efficiently to cash-strapped banks.

4.3.1 Robustness of Models involving Interbank Market and Policy Implications

In this section, we have focused on the inability of the interbank market to provide funding efficiently due to the existence of financial frictions or market imperfections. The inefficiency that result may be strong enough to force otherwise solvent but illiquid banks into insolvency, with system-wide consequences. The type of contracts that exist in each model are pre-specified: in Bhattacharya and Gale (1987), banks write contracts beforehand i.e prior to observing the liquidity shock. In models of Alger (1999), banks write the contracts after the realisation of the liquidity shock and turn to the lending markets only ex-post.

In the interbank market for lending, the first best solution is reached when the optimal level of liquid reserves can be achieved. If this requirement can be attained ex-ante, then any form of trading in the interbank market can maintain it ex-post. In the case of non enforcement of this optimal level of liquid reserves, the second best is reached. In that case, some form of noisy monitoring, would constitute some form of Pareto improvement. Bhattacharya and Gale (1987) thus offer a rationale for official monitoring of liquid asset holdings by banks, suggesting that liquidity shortages may arise as a result of banks' incentives to free ride on interbank liquidity, rather than holding liquid assets themselves. In the presence of credit risks in the interbank market for liquidity provision, the first best level of liquid reserves, no longer guarantees efficiency. As seen in Alger (1999), banks may be unwilling to lend if

credit risks are deemed to be too high. Possible policy solutions include introducing mechanisms that allow trade to take place in the interbank market, for example, through central bank credit lines.

The case for LOLR should also be put into perspective. As mentioned in section 3.2.1, LOLR serves two purposes: prevention of spread of illiquidity problem across banks and prevention of illiquidity problem from turning into a bankruptcy one. While we were overwhelmingly concerned with the former use of LOLR in section 3.2.1, we shall be concerned with the latter use in this section. Regarding the role of LOLR in dealing with banking crises, Goodfried and King (1988) argue that solvent banks could perfectly insure against the possibility of bank runs via a sophisticated interbank market, suggesting that central banks should focus on maintaining a sufficient amount of liquidity in the system, rather than providing the LOLR facility. However, as we have seen, various forms of market imperfections prevent the interbank market from operating efficiently and may turn an illiquidity problem into an insolvency one.

Donaldson's (1992) argument that cash-abundant banks may abuse of their monopoly power and charge above competitive rates, suggest that there is a clear cut case for LOLR. Goodhart and Huang (2004) argue that, if the amount of funding needed is beyond the reach of the interbank market or if the interbank market is plagued by coordination failure, it will be unable to provide liquidity to cash strapped banks. They also argue that the interbank market may not be abloe to provide insurance against liquidity shocks if these shocks happen to be systemic, affecting the whole banking system.

Rochet and Vives (2002) argue that, under certain circumstances, LOLR may be welfare improving. It prevents inefficient liquidation of a bank's assets and improve welfare if the central bank has perfect information about bank's fundamentals (i.e can distinguish between a liquid and an illiquid bank). In most cases, imperfect information may mean that public authorities will be confronted with a situation in which they do not observe the solvency of banks they are trying to save through emergency funding. In these instances, they may face the dilemma open to all policymakers in the face of imperfect information: that of either providing funding to illiquid banks that are actually insolvent or that of refusing funding to illiquid banks that are actually solvent. In most instances, in the face of imperfect information, policymakers need to weight the benefits of providing funding (in terms of preventing illiquidity from turning into bankruptcy or preventing the spread of a crisis from bank to bank) against the costs of so-doing (in terms of bailing out insolvent banks, moral hazard costs and absence of peer monitoring), and come up with an optimal plan. Ostensibly, this may mean that the optimal plan varies from case to case.

Repullo (2003) also provides conditions under which a LOLR would be welfare improving, by discussing the effect of LOLR activity on holdings of liquid assets by banks. Due to high costs involved in holding liquid assets, LOLR may prompt banks to lower their holdings of liquid assets,

thereby leading to more efficient outcomes. Naqvi (2003) shows that, if the supervisory process is subject to noise, then the ex-post gains in efficiency, resulting from holding a lower stock of liquid assets, may be outweighed by the ex-ante inefficiencies induced by moral hazard, which is conducive to lower rates in the economy.

SECTION C: OTHER RELATED ISSUES

5. Macroeconomic Issues

5.1 Financial Accelerator

Financial Accelerator models deal with the relationship that exists between a financial system and the real economy. Unlike models we have seen so far in this paper, most models under the realm of financial accelerator, abstract from financial intermediation (i.e do not subject the analytics of the Savings-Investment nexus as part of the model). Rather, the focus is on how, in the presence of frictions (in the form of informational asymmetries or limited commitment), financial systems propagate shocks to the real economy and amplify real business cycles. The result is excess volatility and larger swings in business cycles, relative to the situation that would prevail with no frictions. Most financial accelerator models focus on the health of debtors' balance sheets or debtors' net worth, as the main vehicle through which informational asymmetries propagate a shock to the real economy. These financial accelerator models are taxonomised as thus:

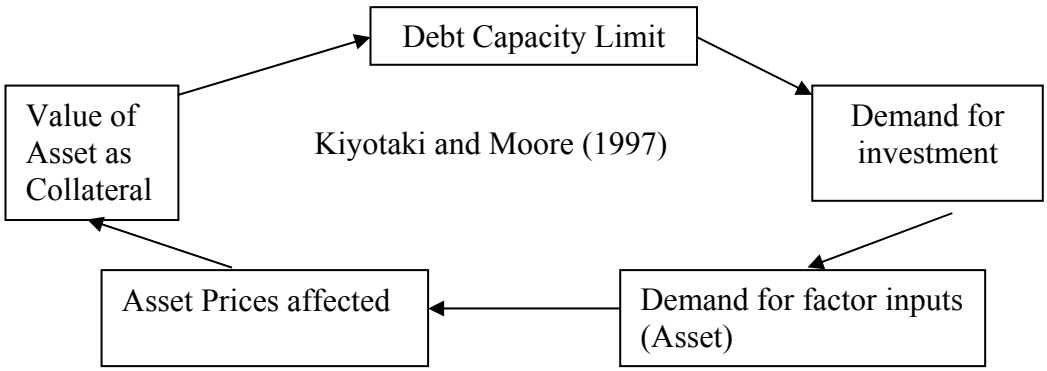
DEBT DEFLATION THEORY – The debt-deflation theory was advocated by Irving Fisher in 1930s in the wake of the Great Depression. It highlights the importance of (fixed) nominal debt as the main propagating mechanism of large and persistent swings in business cycles. An unexpected deflation would cause an arbitrary redistribution of income from those who have borrowed money in fixed nominal terms to those who have lent money because the amount owed in real terms is higher. Debtors have higher marginal propensity to consume than creditors. Thus, the decrease in income that results for debtors exceeds the increase in income available to creditors. The decline in net worth of borrowers lead them to cut back on current spending and all future commitments, sending the economy down further. At an aggregate level, the economy is worse off with real output declining.

BERNANKE AND GERTLER MODEL (1989, 1990) – This model considers optimal financial contracts in the presence of moral hazard. There is information asymmetry in the form of agency costs that lenders have to pay in order to monitor borrowers accurately. Because it is costly to align the interests of lenders and borrowers, lenders demand a higher share of the returns from their investment projects, relative to the case when there is no informational asymmetry. Thus, external finance is costly relative to any form of internal finance. The higher internal finance, the lesser the extent to which external finance is needed and the lower is the external finance premium. This negative relationship

between internal finance and the external premium (cost of investment), creates some form of mechanism that amplifies business cycles when there is some initial shock. For instance, assume that there is a negative technological shock that reduces the current and future cash flows of firms[22]. This induces a greater need for external financing while raising the firm's external funds premium, and consequently, the costs of new investments. Reduction in investment will lower economic activity and future cash flows, amplifying and propagating through time, the effects of the initial technological shock.

KIYOTAKI AND MOORE MODEL (1997) – In this model, financial assets act as collateral and also, as inputs used in the production process. This twinned role of financial assets determines the debt limit of borrowers (i.e net worth) and the interaction between these two roles, creates an implicit asset-price channel. Lenders demand borrowers to post collateral in order to prevent them from defaulting strategically. The value of assets as collateral determines the maximum amount that borrowers can borrow. This debt limit will, in turn, determine the amount of investment that cash-constrained firms must undertake and, by correspondence, the demands for factors of production. Since assets also act as inputs, their prices will be affected. This affects debt capacity and the vicious circle process goes on.

Illustration : The vicious circle in Kiyotaki and Moore (1997)



There are three facts about financial accelerator models:

- The nature of debtors' balance sheet lies at the heart of the model. In the debt-deflation theory, fixed nominal debt determined borrowers' net worth. In Bernanke and Gertler (1989, 1990), it is the external finance premium. In Kiyotaki and Moore (1997), it is the value of collateral;
- In all cases, the firm undertaking the investment project is cash-constrained. Thus, the need for external finance arises naturally given that internal finance alone would not suffice to fund investment projects;

[22] Firms are assumed to be cash-constrained i.e they need to rely on external finance for their investment projects.

- Business cycles have an asymmetric nature in that they tend to be more pronounced in downturns than in upturns. *Crucially, the stronger the need to rely on external funds, the stronger the financial accelerator.* During downturns, an increasing number of firms become cash-strapped because of the direct impact that downturns may have on their liquidity positions. The need for external finance is thus strong during economic slowdowns. During upturns, the external premium decreases and the firm's debt capacity increases as the firm's balance sheet improves. Firms rely less on external funds in economic recoveries. The potency of the financial accelerator thus varies with the business cycle – being fundamentally strong during recessions and weak during recoveries / booms. Interestingly, this means that downward swings are larger and exhibit more persistence than upward swings. This asymmetric nature of swings retains a powerful implication for the appropriate shape and design of monetary policy. *In those economies in which firms are cash-constrained, central bank needs to be more aggressive at relaxing monetary policy during downturns than at tightening monetary policy during upturns.*

5.2 Banking (Credit) Channel of Monetary Policy

The previous section dealt with how asymmetric information and costly enforcement of contracts create agency problems in financial markets. As aforementioned, an external finance premium, which is a wedge between the costs of funds raised externally (by issuing debt or equity) and the opportunity cost of funds raised internally (by retaining earnings), has an important role in economic activities. The size of the external premium reflects the degree of imperfections in credit markets that drive a wedge between the expected return received by lenders and the costs faced by borrowers.

It is important to note that, in addition to its effect on interest rates, monetary policy will also affect the external premium in a complementary fashion. Thus, the direct effect of monetary policy on interest rates, will be amplified by changes in the external premium. This supplementary effect helps explain the potency of monetary policy effects on real output. In particular, two mechanisms have been delineated as linkages between monetary policy and the external premium: the balance sheet channel and the bank lending channel.

BALANCE SHEET CHANNEL - This channel has its roots in the basic mechanism underpinning the Bernanke and Gertler model (1989, 1990) outlined earlier. A borrower's net worth is inversely related to the external finance premium. Thus, monetary policy will affect the external premium, through its effects on borrowers' net worth. Through this mechanism, the quality of debtors' balance sheet will affect their terms of credit. As a result, their investment and spending decisions will be affected.

Shifts in policy affect the financial health of borrowers in several ways. Tightening monetary policy by raising interest rates will directly reduce the net cash flows of borrowers and dent their investment

spending commitments. These high interest rates are associated with declining asset prices, which may affect borrowers' collateral value and hamper borrowers' credit limits – with real effects on output if borrowers have to cut back on future investment projects. Lesser collateral also affects lenders since their ability to give loans will be restricted. There will be adverse selection problems in the lending market with the increase in market interest rates due to monetary policy tightening – in that, only poor quality borrowers will be willing to borrow at higher rates. Lower net worth and lesser collateral will also encourage moral hazard from borrowers because they will have a greater incentive to engage in risky investment projects. Since taking on riskier investments makes it more likely that lenders will not be paid back in probabilistic terms, a reduction in the firm's net worth will lead to a decrease in lending and subsequently, in investment spending.

THE BANK LENDING CHANNEL – The bank lending channel works on the asset side of banks and begins with the premise that monetary policy shifts affect the external finance premium through shifts in the supply of bank loans. Bernanke and Blinder (1992) find that, in addition to the traditional effect on interest rates which works through bank deposits, the transmission of monetary policy works through bank loans as well. This view recognises the important role that banks play in channelling funds to small and dispersed borrowers who often lack access to alternative sources of finance from capital markets. This speciality of banks to small borrowers give them a comparative advantage in deriving economies of scope between their borrowing and lending businesses[23]. If the supply of loans is disrupted, bank dependent borrowers may be shut off from credit. Thus, decreasing the supply of loans is likely to increase the external premium and reduce real economic activity.

Several conditions must hold if there is to be a distinct bank lending channel: First, bank loans and any alternative source of funding (e.g bonds) must be imperfect substitutes among bank assets and for business capital. This assumption creates a distinct role for bank loans and suggests that they are qualitatively different from bonds; second, there exists cash-constrained borrowers who are too small to borrow in the capital markets and who thus rely extensively on bank loans for finance; third, the central bank is assumed to be able to influence banks' ability to lend through appropriate monetary policy; Fourth, there are imperfect price adjustments in order to allow monetary policy to have real effects on output.

The credit view is important for several reasons: it highlights the fact that monetary policy can affect real output without much variation in market interest rates. Since there is a well-determined effect on banks' assets side, it offers a fresh and innovative insight into how improvement in banking system can affect the efficiency and effectiveness of the monetary transmission mechanism. Furthermore, the credit channel can explain the distributional effects of monetary policy on lenders and borrowers, while the alternative sources of transmission mechanism (e.g exchange rate channel, asset price channel, interest rate channel etc) cannot.

[23] The advantages may manifest in the form of lower costs of keeping reserves and "relationship banking" that combining both activities can entail.

In a nutshell, the credit channel highlights the view that bank loans are different from alternative sources of finance. Because of banks' special ability to deal with small borrowers who lack alternative sources of funding, they can best cope with any problem of informational asymmetries that may be pertinent to small borrowers. Thus, any tightening of monetary policy that reduces the supply of bank loans will starve small borrowers of cash. Ultimately, investment projects will have to be postponed and real output cut back.

6 Conclusion

In this paper, we were concerned with identifying the key market failures responsible for creating and propagating a crisis across banks. Using a well defined taxonomy, we have analysed the resulting implications for policy mitigation. The proposed categorisation enables us to round up the main arguments as follows:

- For models of financial contagion involving multiple banks and direct balance sheet links, the theoretical literature suggests that central bankers must pay attention to the network structure as ex-ante crisis prevention measure. If network structure is inappropriate and contagion occurs, then policy measures can be administered at the bank experiencing the initial liquidity shock. Because the contagious effect manifests itself purely from contact links or balance sheet links, these policy measures do not represent an externality to other banks in the setup. By preserving the balance sheet of the cash-strapped bank, they preserve the balance sheet of the whole system;

- For models of financial contagion involving multiple banks and informational externalities, increased transparency seems to be the key ex-ante measure. Ex-post policy measures may work in pre-empting a crisis at the crisis-catalyst bank but they may have an externality on other banks;

- For models where asset price changes act as major transmission channel or source of fragility, financial fragility may occur if the market for hedging against risks, is incomplete. Excess asset price fluctuations at a time when banks need liquidity the most, may result in an undersupply of liquidity to cash-strapped banks. In this case, repurchase agreements by the central bank can be helpful as a corrective mechanism designed to keep asset prices stable;

- For models of financial fragility based on imperfect information in interbank market, the nature of liquidity underprovision depends crucially on the form of the market imperfection. Policy measures should commensurate with the particularities of these market imperfections;

The taxonomy we have adopted also enables us to put LOLR activity into perspective. As mentioned in the main text, LOLR may be carried out either to prevent a crisis at one bank from taking systemic proportions or to prevent an illiquidity problem from turning into insolvency. The former argument assumes complete information and can be justified in our taxonomy in the scenario in which banks are contractually linked through the interbank market in deposits. The latter argument takes place in a setting in which there is asymmetric information and can be justified in our taxonomy, where the interbank market may undersupply liquidity to cash-strapped banks due to market imperfections. In some cases, a cost-benefit analysis must be carried out as the central bank may be lending to banks that are actually insolvent and illiquid while banks that are solvent but illiquid, may not get the much desired finance.

We have also come across arguments in the paper showing that under certain circumstances, financial crises can be benign. They may be good because they discipline bank managers against acting opportunistically (Calomiris and Kahn, 1991); they provide a commitment device to bankers to use their loan negotiation skills on behalf on depositors rather than using these skills for their own personal advantage (Diamond and Rajan, (2001); they provide contingencies that allow the risk sharing allocation to be achieved (Allen and Gale (1998, 2004); (in case of multiple banks) they provide a mechanism that induces peer monitoring among banks in the interbank market (Rochet and Tirole (1996)). Theories that suggest that bank runs are good or efficient, do not make the case for public policy intervention sacrosanct. After all, if the by-product of an efficient financial system is a financial fragility or crisis, any attempt to tackle the crisis will impinge on the ability of the financial system to operate efficiently. Any attempt to introduce policy measures to solve a financial crisis in this circumstance, may be welfare-reducing.

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8 Appendix

Synopsis of Financial Crisis Initiators, Propagators and Policy Lessons

Table 7: Financial Crisis Sources

Financial Crisis Initiators	▪ Asymmetric information ▪ Coordination failure problems in depositors' game ▪ Payoff externalities in depositors' game
Financial Crisis Propagators	▪ Overlapping network of connections (interbank market in deposits and loans): network externalities ▪ Informational Spillovers and Correlated fundamentals ▪ Common exposure to fundamentals ▪ Inefficiencies in Financial markets, due to incomplete markets and incomplete contracts, or market power or asymmetric information ▪ Inefficiencies in Interbank market, due to market power, free-riding, limited commitment

Table 8: Financial Crises Triggers

Sunspots or 'extraneous' variables	▪ Arbitrary shifts in expectations lead to coordination failure and to multiple equilibria (Diamond-Dybvig(1983))
Arrival of new information	▪ New (noisy) information sometimes coordinates beliefs and lead to a unique outcome (Chari-Jangannathan (1988), Jacklin-Bhattacharya (1988), Goldstein and Pauzner (2000), Morris and Shin (1998, 2000)) ▪ New information can lead to contagion, with interbank exposures (Dasgupta (2000))
Productivity Shocks	▪ Exogenous shocks can lead to coordination failure, even in the absence of informational asymmetry (Diamond-Rajan (2001)) ▪ Exogenous shocks are a necessary condition for financial contagion to occur in models with direct interbank exposure (Allen-Gale(2000), Freixas, Parigi and Rochet (2000)0 ▪ Can trigger banking fragility and currency crises (Aghion, Baccheta, Banerjee (2000)) or financial accelerator (Bernanke-Gertler (1989, 1990), Kiyotaki-Moore (1997))
Financial Shocks	▪ Financial asset price declines can precipitate financial fragility and trigger liquidity problems (Allen-Gale (1998))

	and contagion (Donaldson (1992)) ▪ Can trigger banking fragility and financial accelerator (Bernanke-Gertler (1989, 1990), Kiyotaki-Moore (1997))

Table 9: Policy Implications

Eliminate Coordination failure	▪ The idea is to coordinate expectations on the right outcome: e.g Deposit insurance, Suspension-Of-Convertibility (SOC), promotion of transparency, Capital Requirements.
Promoting efficiency of financial markets and of the interbank market	▪ The idea is to remove market imperfections or any form of hinderances that prevent an efficient provision of liquidity: e.g Using central bank policy intervention, in the form of repurchase agreements, to prevent asset prices from falling
Eliminate any risk of contagion	▪ The idea is twofold: (1) appropriate use of policy instruments as crisis prevention and crisis management policies; (2) appropriate design of network structure to make system more resilient to shocks and mitigate the onset of contagion e.g With respect to (1), Lender-Of-Last-Resort (LOLR), bailout guarantees, collateralised requirements for involvement payment systems restrictions of credit exposures; With respect to (2), adopt a 'complete network' as far as possible, to siphon off any possibilities of interbank loss exposures
Reducing impact of the Financial Accelerator	▪ Appropriate use of monetary and fiscal policies in a countercyclical way ▪ (For open countries): Increase interest rates if proportion of foreign-currency denominated debt is high and if elasticity of output with respect to interest rate is low; else, reduce interest rates