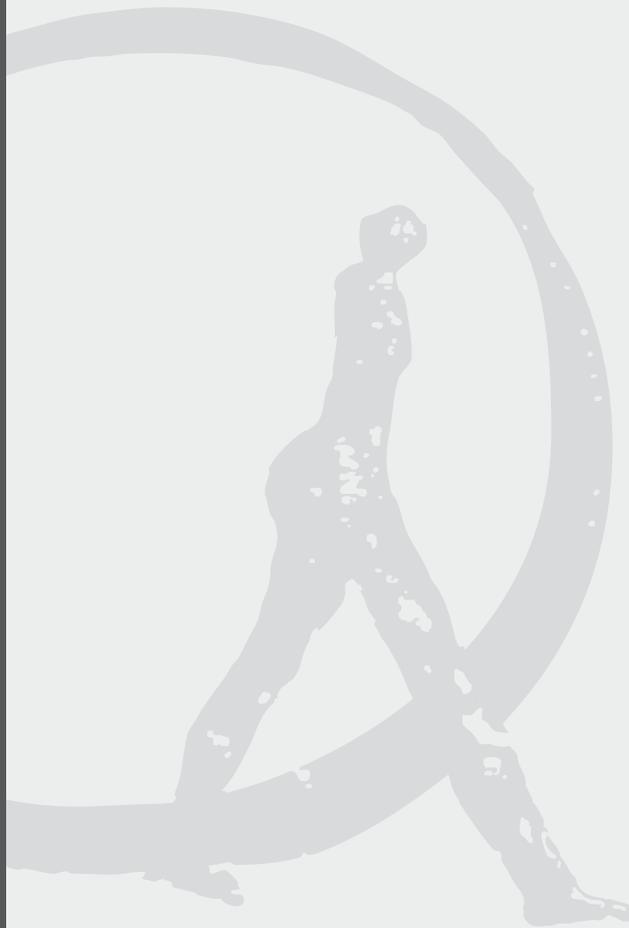


Banking on Liquidity

Liquidity, Collateral and Derivatives

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Abstract

Changes in the nature and magnitude of banking activities over the past few decades are fundamental to comprehension of the failings that resulted in the financial crisis. The provision of financial risk management services and products by banks on the scale documented appears problematic. Derivatives contracts are the principal instruments used in financial risk management. The role and extent of liquidity and collateral security in facilitating these developments is investigated and policy recommendations advanced.

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EDHEC pursues an active research policy in the field of finance. EDHEC-Risk Institute carries out numerous research programmes in the areas of asset allocation and risk management in both the traditional and alternative investment universes.

Introduction

Banking has changed markedly in the past forty years.¹ The 'traditional' business of effecting payments, taking deposits and making advances has been replaced as the predominant activity by the provision of financial risk management services and products. By predominant we mean that these latter activities dominate the banking culture rather than constitute the majority of assets of the banking system. Derivatives contracts are the principal method of provision of financial risk management services. Associated with this move, there has been a shift towards increasing use of collateral security, including private assets,² for both funding and the derivative contracts involved.

Diversification of the scope of a bank's activities is not the same as diversification in the context of asset portfolio optimisation. To the extent that derivatives and banking activities are conducted within the same company, the bank's entire liability structure is exposed to the failure of any and all of these activities.³ Notwithstanding that particular activities are 'ring-fenced' in special purpose companies within a banking group, the bank is still exposed to reputation risk. It was evident during the crisis⁴ that the central role of trust in banking was deemed sufficient by management to override such arrangements as bankruptcy of remote vehicles proved unacceptable and ineffective in practice. It appears that broadening the scope of a bank also entails increasing its scale;⁵ too-big-to-fail and too-big-to-save then emerge as issues. Moreover, though banks have broadened the scope of their activities, there is little diversity among them. Diversification is, in any case, of extremely limited use when faced by an aggregate liquidity shock;⁶ all asset prices fall in those circumstances.

Liquidity is central to the analysis and the concept is described briefly in box 1. The role of traditional banking in the redistribution of liquidity is well-known and understood; however, in financial risk management the role of the banks differs; in this case it is liquidity insurance, via the instrumental form of derivatives contracts. Liquidity insurance is a role more usually associated with the central bank and monetary authorities rather than commercial banks. The effects of derivatives and collateral security on liquidity are examined in this paper. In the interest of brevity, we omit consideration of issues of disintermediation such as the role of money-market funds, though these are related.

The issue of liquidity is not new to this banking crisis; it has arisen throughout history.⁷ Even proprietary trading by banks has a long, if not entirely illustrious, history as many banking houses began their lives in trade, shipping and insurance. However, the role of derivatives, as well as the degree of reliance upon markets, is new.

The past few decades have been characterised by many observers as a period of intense financial innovation and "good" financial risk management. Such innovation⁸ could be regarded as part of the normal Schumpeterian⁹ view of the process of a profit-maximising economy; but the natural question which then arises is why this innovation should occur within the banking system.¹⁰ In particular it is not at all obvious why a complex network, the banking system, which evolved for

1 - Broadly speaking, since the breakdown of the Bretton Woods agreement and the emergence of a market culture.

2 - A private asset is a private sector obligation, such as a company's loan from a bank.

3 - This fact must raise concerns over practices such as economic "capital allocation" which are commonly used in bank management performance metrics.

4 - The costs and hence undesirability of financial crises are covered in Honohan & Klingebiel [2000]

5 - The related question of an optimal size for the financial sector is addressed in Bini Smaghi [2010]. It is worth noting his assertion 'However, when they [the financial markets, including banks] become "too large", relative to economic fundamentals, problems like financial complexity, poorly understood financial innovation, herding behaviour, and endogenous risk-taking - to name just a few - suddenly outweigh the benefits'. The view attributed to Paul Volcker on this topic by the BBC's Robert Peston in a blog of his recent interview with him is 'America's financial sector became far too big, relative to the US economy.'

6 - This is related to Keynes's observation in the *General Theory*: 'Of the maxims of orthodox finance none, surely, is more anti-social than the fetish of liquidity, the doctrine that it is a positive virtue on the part of investment institutions to concentrate their resources upon the holding of "liquid" securities. It forgets that there is no such thing as liquidity of investment for the community as a whole.'

7 - The orations of Demosthenes, in Athenian Greece, for and against the banker Phormio provide accounts of bank failure which still resonate strongly in a modern banking setting. The Roman crisis of AD 33 shares even more characteristics with the recent crisis. There, failure of minor banks in the Levant led to the collapse of a major house in Rome and contagion threatened all others. Some laws were suspended and 100 million sesterces were made available by the State which also created a state-owned bank. Suetonius and Tacitus both reported great shortages of money and fire-sales of debtor bank assets.

8 - In the field of industrial organisation it is usual to distinguish between incremental and drastic innovations, while in the financial innovation literature a distinction between process and product innovations is more frequently seen. It is not unusual to see developments which contain features of both.

9 - Though popularised by Schumpeter in his book *Capitalism, Socialism and Democracy*, the idea of creative destruction is perhaps better attributed originally to the German sociologist Werner Sombart.

10 - As most financial risk management is best characterised as insurance, this question is not trivial. For example, banks rely upon the central bank for liquidity insurance which alone must raise doubts as to the wisdom of their offering liquidity insurance to the world more broadly.

the purpose of liquidity redistribution,¹¹ and is presumably optimal in some evolutionary context, should be appropriate for the purpose of redistribution of financial risk even though this settles in money. It is clear, however, that the process of implementation of redistribution of financial risk has consequence for liquidity both locally and systemically.

In this paper our focus is more limited—on the 'repo', or secured lending market¹² and upon derivatives contracts, including the collateral used to support them.¹³

Box 1 - Liquidity

Justice Potter Stewart's avoidance of a definition of pornography using the pragmatic 'I'll know it when I see it' is not appropriate if we are to conduct any meaningful analysis of liquidity. Unfortunately, in common with many economic concepts, some confusion of stocks and flows is evident; liquidity has a very wide range of meanings.

If we begin by considering money to be an instrument of final settlement, we notice that there is a distinction between money as a medium of exchange and as a store of value; there is a broad correspondence here to the flow and stock of liquidity. An investment manager's concept of the liquidity of a security as the ease of trading with little impact on the price (with, perhaps, an ancillary value condition) is an example of a flow measure of liquidity. The efforts exerted by recurrent-debt issuers to enhance the tradability of their issues is another; recall that the market convention that large issues would be more liquid than small is at first surprising since there are few goods that increase in price (or for the issuer decline in cost) with increasing supply.

It is also necessary to follow the academic distinction between inside and outside money; inside money consists of private obligations while outside money consists of central bank obligations, consumer savings and foreign holdings in the currency. A cheque drawn on a bank is an example of inside money while a currency banknote is an example of outside money.

Liquidity, in a stock context, can be thought of as the 'moneyness' of an asset; the degree of substitutability of private for public assets or equivalently inside money for outside. It should also be obvious that a stock of liquidity is a necessary precursor for the exchange role. The question in practice is one of adequacy of the stock, which is itself related to the efficiency of the payments transmission system. The role of banks in the creation of credit and inside money is central. Here it is usual to draw a distinction between market liquidity and funding liquidity.

In the case of market liquidity it is the asset side of the balance sheet which is relevant; the exercise is one of determining the degree to which assets other than cash may be reclassified as cash—their cash equivalence. Funding liquidity, by contrast, is concerned with the liability side of the balance sheet. Also known as 'roll-over' risk, this arises from the maturity transform inherent in banking when short term deposits are recycled as longer-term loans and advances. It is usual for banks to utilise a mixture of market and funding liquidity; one of the more powerful criticisms of the circumstances which led to the recent crisis was that an excessive dependence upon market liquidity had developed. Reliance upon consumer savings deposits in funding is attractive from both their tendency to persist and also the fact that they are outside money, which interbank deposits are not.

Securitisations, the transfer of interests in particular pools of assets by liability issuance, involve both asset and liability sides of the balance sheet. The market liquidity of assets is being exchanged for funding liquidity. One issue with funding liquidity that has received relatively little attention is that its resolution will typically dilute the interests of other liability holders. Many derivatives have the property that they may be either assets or liabilities depending upon the state of the world with respect to their underlying. By design, many derivatives involve no initial transfer of liquidity but are subject to liquidity demands under a market-consistent pricing regime. The implicit leverage in such transactions can be very high indeed.

Hoarding of liquidity, the store of value function, can be achieved by the purchase of government securities, such as Treasury bills, reducing the collateral available for support of banking and derivatives activities.

11 - A primary economic function of banks.

12 - Box 2 is a description of current practices in these markets.

13 - The sums involved as collateral security are substantial. ISDA (International Swaps and Derivatives Association) reports in the preliminary release of their 2010 annual survey that this had amounted to \$4 trillion in 2008 and fallen to \$3.2 trillion in 2009.

Box 2 – Repo Markets

In the simplest case, when a bank takes an unsecured deposit it is implicitly supporting this liability in a general way with a claim on all of its assets, which are predominantly private sector, illiquid, untraded loans and advances. In fact, most financing now occurs in the 'repo' markets rather than by unsecured interbank deposits.

A **Repurchase agreement** (also known as a **Repo** or **Sale and Repurchase agreement**) allows a borrower to use a financial security as collateral for a cash loan at a fixed rate of interest. In a repo, the borrower agrees to sell immediately a security to a lender and also agrees to buy the same security from the lender at a fixed price at some later date. A repo is equivalent to a cash transaction combined with a forward contract. The cash transaction results in transfer of money to the borrower in exchange for legal transfer of the security to the lender, while the forward contract ensures repayment of the loan to the lender and return of the collateral to the borrower. The difference between the forward price and the spot price is the interest on the loan while the settlement date of the forward contract is the maturity date of the loan. Repo lowers the stated assets held while raising cash balances in accounts—it also introduces a liability to repurchase those assets.

In 2007, repo and financial commercial paper accounted for more than 80% of US M2. More financial institutions than just commercial banks use the market—investment banks and hedge funds finance much of their activity here. In early 2007, repos accounted for 40% of US investment banks' total funding.

A typical repo transaction tenor is just a few days, though open repo, which continue unless terminated, is occasionally available. Prior to the crisis most repo activity generated cash equal to the full prevailing market price of the security at the time the repo agreement was consummated—repo transactions are usually based upon market prices. With less 'liquid' or highly volatile securities, 'haircuts' are sometimes applied to repos; in this case the seller might deliver securities worth 100% against receipt of cash of just 98%—the 'haircut' or margin being 2%. There is a correspondence between the initial margin applied by central clearing houses (CCPs) and the 'haircut' of repo transactions. In theory, the 'haircut' is a function of the volatility of the security purchased (see Box 6 for more detail); it is a safety margin in price to accommodate the possibility of adverse price movement should the security need to be liquidated upon the default of the repurchasing party to the agreement. It is also a relevant consideration should the lender (purchaser) wish to use that security as collateral itself in some new financing activity. This ability to use collateral received in further financing activity is known as the right of re-hypothecation. In repo, title, but not beneficial ownership, passes to the purchaser. The buyer does not know if a security sold is beneficially owned by the counterparty.

Collateral is also used as a risk mitigant for the exposures associated with derivatives. The collateral required is firstly a function of the degree to which the contract is currently in or out of the money and secondly, theoretically, a function of the potential future exposure of the contract. This second element is related to the volatility of the contract value and is determined by the variability of the underlying. Unlike repo, the collateral posted to secure OTC derivatives contracts is predominantly cash, rather than securities. It is usual to net contract exposures and post collateral bilaterally among the counterparties to derivatives transactions.

In the event of default of a repo counterparty, the securities are seized and may be immediately realised by sale in the market. Title IX of the US 2005 Amendments to the Bankruptcy Code enlarged and clarified the 'safe-harbour' provisions, which enabled this practice, for financial contracts under the US bankruptcy code; this can be viewed as an evolution of existing law rather than a radical new doctrine. It expands the definitions of financial contracts, qualifying contracts, and now includes hedge funds. It also provides for cross-product netting of multiple contracts and protects creditors' rights to close out a contract. Similarly credit support agreements/annexes for ISDA documented OTC derivatives transactions typically grant this right and, of course, bankers' usual rights of 'set-off' or netting of exposures may also apply. This process occurs outside of the formal insolvency process; the automatic stay of the US bankruptcy process is not binding. This may be unfortunate in as much as a failing bank will typically have posted most or even all of its high quality assets as collateral security with the result that the rump institution has effectively been 'hollowed out'. Somewhat ironically, one of the reasons stated for this amendment was harmonisation with the Federal Deposit Insurance Act and the Federal Deposit Insurance Corporation Improvement Act.

Many motivations have been advanced for the development of derivatives markets but, in general terms, these arise as responses to market inefficiencies or imperfections. The arguments most favoured by practitioners tend to follow the line that these contracts help to complete markets and improve allocative efficiency. However, it is evident that some are motivated by concerns over regulation and taxation and, more recently, it has been suggested that some are just driven by no more than the banks' desire to generate fee income.¹⁴ We shall restrict ourselves to observing that Elul [1995] showed that welfare may not be improved by the introduction of non-redundant assets into incomplete markets¹⁵ and to considering the frequently made claim that derivatives improve market liquidity. In a more specific instance, a non-redundant contract can help to bring a market closer to completion, but that means that there was previously a risk present in the market system which was untraded and unpriced. The derivative merely serves to add this risk to the priced and traded market segment.¹⁶ It is undoubtedly true that derivatives have facilitated trades¹⁷ which would not otherwise have occurred—that is to say, they have served to increase liquidity in its flow sense. However, in the absence of material improvements to the liquidity or payments infrastructure, we would expect such an increase to be associated with an increased liquidity stock demand. In a system where private provision of liquidity is inadequate this will tend to exacerbate liquidity problems. Moreover, it should be obvious that liquidity must have a cost; otherwise, all assets would be liquid.

In the course of this paper we consider a number of related issues such as the incentive effects of the introduction of these new contracts and markets. We conclude with a number of recommendations or policy actions.

We recommend separation of activities functionally into a traditional bank and a financial risk management services company. Banks may act as securities markets brokers but not as securities underwriters. Banks may use derivatives for their own asset and liability management but not become market-makers or traders in this form of liquidity insurance.

Alternately, if separation of activities functionally is not desired, we should prohibit the use among banks of collateral security as support for OTC derivatives contracts. This should be expected to have the effect of lowering the volume of derivatives transactions and also concentrating the minds of the bankers on the credit status of their counterparts.

The latter of these recommendations in the context of monetary and associated policies is discussed later.

1. Banking Today

The idea that banks have changed in nature over the past few decades is not new; in 1995 Edwards and Mishkin¹⁸ published a paper entitled: 'The Decline of Traditional Banking: Implications for Financial Stability and Regulatory Policy'. In this, they observe that: *'To survive and maintain adequate profit levels, many US banks are facing two alternatives. First they can attempt to maintain their traditional lending activity by expanding into new, riskier areas of lending... [Second, they can] pursue new, off-balance-sheet activities that are more profitable.'* Amongst the evidence they offer for pursuit of newer activities are the declining share of commercial banks' non-financial lending, their declining relative share of total financial intermediary assets and the rising share of non-interest income in total income—from around 18% in the mid/late 1970s to

14 - The view attributed to Paul Volcker by Peston in his blog is: 'Much financial innovation was designed to extract rent (often in the form of premia paid by gullible investors) rather than making any contribution to the growth potential of the economy.'

15 - This result is not unique. For example, Morrison [2001] showed that credit derivatives can cause disintermediation, lowering social welfare. There is a broader literature which generates adverse effects—see also Allen & Gale [2000] and Allen & Carletti [2008].

16 - It is also obvious that some derivatives have added to the consequence of a risk event. For example, in 2007 Lehman Bros had some \$155 billion of liabilities which might be referenced in a credit default swap, but there were some \$440 billion Credit Default Swaps (CDSs) outstanding. This implies liquidity transfers of far higher magnitude under contract exercise, the default event, and also far larger transfers under CDS collateral agreements before that. If written as insurance contracts the principle of 'insurable interest' would limit such exposures to the amount of the outstanding liabilities.

17 - There is a related issue which merits detailed research. Dynamic derivatives replication strategies may introduce path dependency into the price process and path-dependent processes are well known to be inefficient. When market activity is dominated by such 'hedging' transactions, it seems likely that prices will not necessarily reflect fundamental information. In this case the process by which the new asset is introduced could offset any completion gains by bringing with it a new source of inefficiency.

18 - Edwards and Mishkin [1995]

35% by 1993. The paper documents the increase of disintermediation and increasing bank activity in, and reliance upon, financial markets. They also observe that derivatives have been prominent in this shift: *'Large banks, in particular, have moved aggressively to become worldwide dealers in off-exchange or OTC derivatives, such as swaps. Their motivation, clearly, has been to replace some of their lost "banking" revenue with the attractive returns that can be earned in derivatives markets.'* In addition, they note the exponential growth of those markets. It should be remembered that then, in 1995, netting and collateralisation of exposures under derivatives contracts was not yet widely practised and the process infrastructure for OTC transactions was also limited.¹⁹

These trends have continued at least until the onset of crisis. In his 2010 Brookings Institution paper entitled "The Crisis", Alan Greenspan reports a continuing significant increase until recent times in the role of non-interest income for US commercial banks (Table 1 below is extracted from Exhibit 16 of that paper). It is noticeable that from the late 1970s, a period usually associated with the development of derivatives markets, banking margins began to be dominated by non-interest income. Over this time, the diversification of activity in the larger banks was greatly facilitated by banking deregulation in the US and the notional exposure of US banks to derivatives has risen from \$16 trillion in 1994 to more than \$200 trillion in 2009—a compound growth rate in excess of 17.5% p.a.

Table 1: Banking margins at select dates (Source: Greenspan [2010] / FDIC)

	Net Income / Total Assets	Non-Interest Income / Total Assets
Av.: 1962-1966	0.766	0.566
Av.: 1978-1982	0.728	0.774
Av.: 1992-1996	1.092	1.949
Av.: 2002-2006	1.276	2.296

The evidence for economies of scope and scale in large-scale banking does not support this shift; Haldane [2010] provides an entertaining review of the recent literature on this in his speech 'The \$100 billion Question'. Stiroh [2004] shows that trading revenues are more cyclical than investment banking revenues, which, in turn, are more cyclical than the traditional banking performance measure, interest income. The concern²⁰ must be that a shift to greater financial instrument trading results in an increase in the banks' exposure to systemic risk.

The nature of the users of derivatives was not clear in 1995, with Edwards and Mishkin asserting that *'most of these derivatives were held by large banks, and were held primarily to facilitate the banks' dealer and trading operations'*, while Salomon Brothers, in a 1994 publication entitled 'Derivatives: New Disclosures Still Fall Short', concluded that qualitative statements in the banks' annual reports suggested that much of their derivative activity was customer-driven. This paper will consider later the question of derivative use.²¹

This growth must give rise to questions as to how or why profitability from the activity can be sustained, as competition can be expected to result ultimately in all gains accruing to the consumer rather than the product producer. It is noteworthy that most financial innovations in the past few decades have been accompanied by opacity (see Box 3)—the analysis of these structures and contracts is at best difficult and often impossible. In this situation, where asymmetry of information prevails,²² it should be expected that bankers, as delegated agents of their shareholder principals, would be able to capture significant rents at the expense of their shareholders.²³

19 - The May 2010 Federal Reserve of New York white paper 'Tri-Party Repo Infrastructure' is a response to process weaknesses which became evident in the course of the crisis. It is also a useful introduction to the technicalities of the repo market. However the recommendations of the Payments Risk Committee task force contained within it are questionable in many regards.

20 - It is understandable that some have concluded that the scale of the large banks' activities is now motivated more by a desire to exploit the 'too-big-to-fail' option of government support than the economics of scale and scope.

21 - Survey data now available, though inevitably incomplete, throws light on some aspects. The 2009 ISDA survey of derivatives usage by major corporations reports that 94% of them use derivatives for risk management purposes. In many countries all large companies use them, in some developing economies, such as China, the usage is much lower—in that case, at 62%. Usage by sector is above 90% for all sectors except services, which given the lower capital intensity of that sector should, perhaps, not be surprising. The usage of credit derivatives is confined to the financial services sector where 76% use them—by contrast, among all other sectors the usage is just 2%. The predominant forms of derivatives used are interest rate swaps and foreign exchange derivatives—both of which are mature product ranges, holding little prospect of the early super-normal returns associated with innovation. The use of commodity derivatives appears to be confined to companies with specific industrial needs, and presumably specialised knowledge. This survey, unfortunately, throws little light upon the volumes of derivatives written with corporations by the banks, and may be subject to the possibility of distortion in the sense that some of the banks must be counterparties to the transactions reported by both non-financial companies and other banks.

22 - The obvious remedy of increased transparency is not without problems, since the possession of common information may increase herding and initiate runs.

In other words, it is not just clients of the banks which suffer under asymmetry of information (see box 4).

Box 3 – Opacity

Three topics are recurring issues in the public debates of the crisis: opacity of financial products, bankers' bonuses and the magnitude of bank balance sheets. This box will attempt to place these issues in a common context.

Most financial innovations cannot be protected by patent or copyright; some are conceived in the academic sector where the express objective is knowledge for all. The logical response to this situation is to protect the bank's intellectual property by maintaining secrecy around germane aspects of an innovation. The hope is that this will enable the bank to recoup its investment, its sunk costs of research and development and go on to gain super-normal profits. Innovations, of course, are usually accompanied by publicity; in part this is reputation building and in part it is merely a search for potential clients for the innovation. Another motivation is to attract other dealers to the innovative market; this is seen as assisting investor acceptance and enhancing liquidity—this is encouragement of flow liquidity.

In the quest to maintain their competitive position many other banks will be interested in innovations, needing to understand how they work, both theoretically and practically. Practical (or process) issues usually determine whether an innovation will prove enduring or merely fragile and transient. Copying enduring innovations is profitable for a bank. The fragile and transient are usually costly both immediately in the development phase and in the longer term.

There is some urgency for a bank wishing to understand an innovation since the passage of time will see the innovation commoditised, with all gains then accruing to the consumer or client.

One of the most effective and quick ways of gaining rapid understanding of an innovation is for the bank interested to hire one of the people involved in the development of that innovation. This can be achieved by offering the person involved better terms of employment, including usually a higher salary. The bank that has developed an innovation will seek to protect its position by offering its key people higher salaries—and rents arise. The discovery of information is costly. This situation was prevalent in a different aspect of international markets in the 1970s; at that time the Eurobond market was in its infancy and institutional investors were few and highly secretive. In large part this paucity of institutional investors arose from the attitude of the authorities and regulatory constraints. The response by the dealer banks was to hire salespeople from competitors—a practice known as 'hiring an address book'.

There is a widely held belief that markets can be developed in most financial instruments. This is an instance where supply is believed to generate demand. Moreover, markets can substitute for adequate models and can replace arbitrage-free replication strategies; the classic illustration of this is the foreign exchange market, with which credit default swaps share many common characteristics. Models can also, in fact, drive innovative markets—the Black-Scholes model is clearly an engine of exchange-traded option prices, rather than a camera or descriptive record.

Markets and acceptance by investors take time to develop. In this situation, using a bank's balance sheet for some or all of an innovative contract is usually seen as an interim measure; the warehousing of stock for future sale. For enduring innovations this is sound, but for the fragile and transient it is not. It does, however, introduce a relation between innovation and scale of the bank.

This box has abstracted from the use of balance sheets to warehouse assets in the process of preparation of securitisations, which was also substantial for some banks.

Jensen [1986] suggests that the principal-agent problem may be resolved by limiting the free cash-flow available to management by heavily loading the institution with short-term debt since the need to return to markets regularly for finance will expose management to market discipline. This remedy, of course, assumes that liquidity is always available in markets and it is also obvious that the investment banks were massively exposed to markets for short term debt roll-over (see box 2) but employee rents were still very high. In the case of Bear Stearns over 50% of their assets were funded in the short-term repo markets.

Box 4 – Bankers' Bonuses

This acrimonious topic arising from the crisis has focussed on the rather nebulous concept of a 'trader', who is, in some way, able to alter the risk-taking behaviour of his institution. It is worth considering a little more fully the institutional organisation of an investment bank. There are salesmen, responsible for contact with client investors, who interact with the investment bank's traders who authorise (or not) transactions as principal with the investment bank's clients. These traders will decide which transactions may be executed based upon their expectations of markets, their inventory and other issues. Any trader will usually have limits to the exposure that may be incurred and above these traders is a manager who determines what those exposure limits may be.

In the absence of other incentives, the natural tendency of a salesman is to protect his clients since these are the source of future business which will determine his long-term income. It was not uncommon in trading rooms after the time of deregulation in financial markets (e.g., the 'Big Bang' in the UK in 1986) when the ethos of client protection was still strong, for traders to complain that 'salesmen were working for the client, not the firm that paid their wages'. The issue of dual capacity which was facilitated by that structural deregulation is being debated again.

Most institutional investors have constraints and limitations on their investment practices e.g. limits on their purchase of equity securities. These restrictions are often viewed by the investment personnel as being inappropriate for them—*forbidden fruit* has its own attractions. This can give rise to collusion between the investment bank's salesman and the institutional employees whereby the institution purchases an eligible investment, say a bond, but one whose value is determined by, say, the value of some leveraged equity. The letter of the investment restriction has been observed, a bond not an equity is purchased, but the spirit has been violated grossly. Institutional portfolio managers with short-term performance hurdles and compensation structures are particularly prone to such collusion. Of course, within an investment bank, the compensation structure may distort the behaviour of sales personnel—the compensation offered to salesmen can be sufficiently large that they will sell securities which are inappropriate for a client, but profit the bank. This may arise from ignorance on the part of the salesman or from base venality.

Traders usually try to avoid 'warehousing' securities which are unsold from an innovative new security. These are, in the main, securities which have low immediate prospects of high trading activity, the principal source of profit for the trading book. Such positions utilise exposure lines which could be better employed trading other securities. When the trader is paid on the basis of his trading revenues, the incentives are to press for greater exposure limits.

A risk-based exposure or allocated capital system is a superior, but still incomplete determinant of the value-added of a trader. Unfortunately, these are subject to the weakness that they reflect hedged positions where the gross exposures far exceed limits, and in extremis, the basis risk in these 'hedges' can prove enormous. There is always some basis risk in a 'hedged' position; this is the source of potential profit. The old adage that the only perfect 'hedge' is an outright cash sale is correct.

Unsold innovative securities are usually held on a segregated proprietary account, approved by management. Obviously, the ability to finance these positions is a concern, but usually minor for most banks; the dominant concerns tend to be the profitability of other parts of a transaction, the relative incentives for the different divisions of the investment bank involved, and the external reputation of the bank. Constructing a compensation system for management is no simple affair as issues such as the promotion of internal co-operation and initiative are a material concern. Externalities, such as the possible systemic consequence, are ignored.

However, it is possible to bring discipline to the situation at the level of the institution. This would involve no more than limiting total incentive compensation paid to be less than, or equal to, the lower of total corporate taxes and shareholder dividends paid in any year. This simple structure, which could be calibrated more finely, aligns the interests of all parties. The incentive for management to overstate current profitability at the expense of the future would be greatly mitigated, and shareholders motivated to monitor the management of their investments more closely.

2. Collateral and Funding Issues

The repo markets peaked in early 2008 when some \$4.3 trillion was outstanding;²⁴ this has declined to around \$2.5 trillion in early 2010.²⁵ The figures quoted here are those of Federal Reserve reporting dealers; there is no aggregate measure of the market size. Obviously, these are incomplete when the figure of interest is the overall market size;²⁶ some estimate that the overall market may be as large as \$12 trillion. The range of widely accepted collateral narrowed significantly in the crisis.²⁷

By contrast, Afonso *et al.*²⁸ investigate overnight federal funds lending and find that the volumes of interbank overnight loans rose from \$177 billion in early 2007 to \$250 billion in the wake of the takeover of Bear Stearns by JP Morgan and then fell to around \$135 billion after the introduction of interest payments by the Fed on required and excess reserves. These authors also find that banks with poor returns on assets used the discount window more after the failure of Lehman Bros. (the requirement to post collateral does not appear to have been a binding constraint)²⁹, but their overarching conclusion is that money markets did not entirely freeze.

If the market reports of difficulty in obtaining term funds are taken as credible, we would expect a significant increase in day-to-day lending volumes as these demands were rolled over in the short term. It is also difficult to reconcile their (Afonso *et al.*'s) finding with the very high levels of reserves which were held at the Federal Reserve by the commercial banks—these rose from \$19 billion in 2006 to \$860 billion in 2008.³⁰ It would be interesting to examine the development of overnight funding relative to reserves held.

Fegatelli [2010] reports on the development of repo activity at one international central securities depository, Clearstream, and shows that repo turnover as a proportion of assets in custody rose steadily from around 5% to peak at 10% in February 2008 falling to less than 7% in August 2008 and interprets this as increasing use of debt securities as collateral. Somewhat surprisingly, the aggregate level of repo outstanding in Clearstream rises steadily all through the crisis period, but the Fegatelli paper also reports 'tri-party'³¹ repo outstanding (stock) in Clearstream as having been steady in the €100 - €150 billion range until March 2008, after which it declines to the €50 - €100 billion range; this decline appears to be matched by an increase in the outstanding Euro General Collateral Pool.³² ICMA³³ report that outstanding repo transactions peaked at €6.8 trillion and subsequently fell to €4.6 trillion in December 2008, in their bi-annual surveys of international market repo.³⁴

The Clearstream and ICMA surveys also report the term structure of outstandings; over the crisis period the ICMA survey shows decreases in the overnight to seven day terms and pronounced increases in the one to three month terms while Clearstream shows a significant increase, almost doubling, of overnight activity with marked declines in maturities in the range from several days to one month—beyond one month the stock increases are substantial. The BIS reports, in an article in its December 2008 quarterly review, a contraction of \$423 billion in the interbank market outstandings. This is a mixed bag of empirical facts that do not sit well with either press reports from the time of total market seizure or much academic analysis of the crisis.

24 - Large scale banking involvement in repo activity is actually a relatively recent phenomenon. Less than twenty years ago many major European Banks were still researching the market, and repo activity in non-dollar currencies is still much less well-developed than the US market. To illustrate this point, consider the UK banks' aggregate sterling assets and liabilities at June 1999—these show total liabilities of £1,317 billion, with liabilities under repo at just £72 billion (5.5%) and corresponding assets of £78 billion (6.0%). The banking system was then a small net lender, principally to investment banks and hedge funds. Repo has assumed a slightly greater role in the sterling markets in the period since, but, at June 2009, it still accounted for only 9.9% of UK banks' total sterling liabilities.

25 - There are many reasons for this decline—among which are the low levels of interest rates, larger haircuts, more stringent collateral quality requirements, the decline of securitisation and smaller trading books held by dealers. It seems that the market will revert to the situation that once prevailed, that only Treasury and high quality mortgage and corporate securities were acceptable collateral.

26 - Federal Reserve [2010] reports tri-party repo at \$2.8 trillion at its 2008 height, and this declines to \$1.7 trillion in recent times. Tri-party is therefore a significant part of all dealer repo financing.

27 - This follows from Gorton G. [2010]

28 - Afonso G., Kovner A., & Schoar A [2010]

29 - Fegatelli P. [2010]

30 - The Federal Reserve H8 statistics report that the cash hoarding was confined to large banks—small banks show no recognisable deviation from trend growth.

31 - The distinguishing feature of a tri-party repo is that a custodian bank or international clearing organisation, the tri-party agent, acts as an intermediary between the two parties to the repo. The tri-party agent is responsible for the administration of the transaction including collateral allocation, marking to market, and substitution of collateral.

32 - The Euro GC pool is collateral eligible for acceptance at the European Central Bank's discount window.

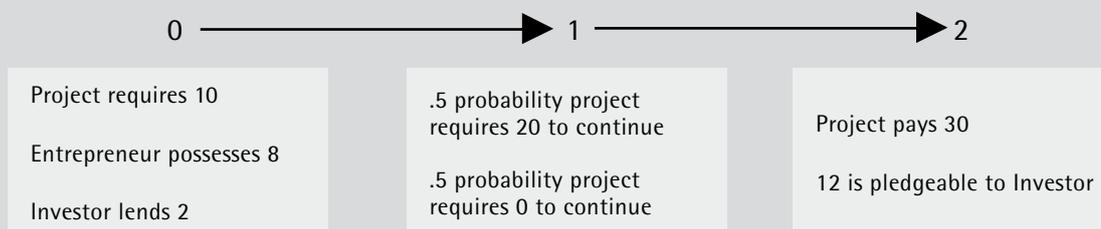
33 - International Capital Markets Association

34 - A number of methodological issues render the absolute values reported by ICMA suspect but the trend evident is more reliable and perhaps accurate in relative terms.

Box 5 – A Framework for Liquidity Analysis

The Holmstrom/Tirole Framework

Holmstrom and Tirole [1998] develop a simple two period model, where an entrepreneur has initial wealth of 8 but wants to engage in a project which requires total investment at time 0 of 10. At time 1 there is no revenue from the project and with equal probability, in order to continue, the project requires a further investment of 20 or 0. At time 2, the project pays off a total of 30 of which just 12 can be pledged ex ante to investors—for simplicity interest rates are zero. This is illustrated below:



In this situation the project is viable for a bank investor as its outlay $[(10-8) + 0.5(20) = 12]$ equals its return. However, reliance upon the market in a finance-as-you-go strategy is not sustainable. Funding just the initial deficit of 2 at initiation results in a need to raise 20 in fifty percent of circumstances and with the prospect of just 12 as its payoff, no bank investor will make this advance of 20 when needed at the intermediate time. The frictions in this model occur within the project, not the market; with just 12 pledgeable to investors, the entrepreneur's claim to 18 of the payoff, rather than the 8 invested, can be viewed as an incentive to overcome moral hazard, an agency cost or other diversion. From the perspective of this paper, the lesson to be taken from this simple model is that reliance upon the market for funding can be misguided in and of itself.

This should also serve as a caution as to the limitations of market-trading based dynamic replication strategies, which lie at the heart of many financial models—most notably the Black, Scholes & Merton option pricing models

Holmstrom and Tirole extend this simple model to the case where the entrepreneur contracts with a bank at time 0 for a line of credit of 20 to be available at time 1. If the line is drawn down, the bank becomes the senior creditor and receives, in priority, the payoff of 12 at time 2, so the time 0 commitment fee should be 4 $[0.5(20-12)]$. The bank profits if the funding is not needed and loses if it is drawn. Note that the bank would not undertake the advance at time 1 (as above) without its having been pre-contracted. It is precisely because the advance is loss-making when made that it needs to be pre-arranged; this is clearly a form of insurance. In this pre-contracting situation the entrepreneur needs at time 0 to raise both the commitment fee (4) and the initial financing deficit (2) a total amount of 6 – investors are prepared to finance this full amount since their payoff is 12 in fifty percent (= 6) of outcomes. The lesson to be drawn from this extension is that committed lines incur losses when drawn in the absence of market imperfections—and that material adverse change clauses are likely to be of little use as a risk avoidance or mitigation mechanism. It is also evident that the derivatives contract requires a higher stock of initial liquidity than the market based finance-as-you-go strategy.

Farhi and Tirole [2009] extend this elementary model and demonstrate that there is a trade-off between liquidity and scale and derive conditions for the relative attraction of funding versus hoarding liquidity. Holmstrom & Tirole [2009] also show that some assets, such as portfolios of equities, may be valueless when the economy is hit by an aggregate shock and may therefore be of no use as stores of value in a macro-economic sense.

As was noted in Box 2, collateral is also used as a risk mitigant for the exposures associated with derivatives positions. There is some evidence that collateral agreements may be asymmetric favouring the large and strong institutions. The Valukas report on Lehman notes large collateral demands from its clearing agents, and recent Bloomberg stories reported that Goldman Sachs held collateral to the value of 57% of its outstanding derivatives assets while posting just 16% on its liabilities. This practice appears, *prima facie*, to be exploitation of market power and monopoly. The New York Federal Reserve observed in a January 2010 report that collateral demands also

played a significant role in the difficulties experienced by Bear Stearns and AIG. In addition, the problems at New Century Financial and the hedge funds Carlyle and Peloton were reported as being related to collateral calls. Thornburg Mortgage went as far as to negotiate a one-year stay of collateral calls through a process that involved raising a new convertible capital note, though it still ultimately failed in 2009.

Guarantees, a form of derivative contract, were extensively supplied by the banks to the conduits they created to remove many assets from their balance sheets. This was a form of regulatory avoidance.³⁵ These contracts, in essence, guaranteed to supply liquidity to the conduit in the event that commercial paper markets were unwilling or unable to do so. Some, but by no means all, of these guarantees were supplied by the bank creating the conduit. It was evident that most bankers considered these liquidity guarantees little more than a 'comfort' to the commercial paper lenders, and priced them generously. In the event, this proved not to be the case.³⁶ When considered in conjunction with the issues of reputation and trust, the conduit assets were returned to the sponsor bank balance sheet, which compounded the liquidity difficulties being experienced in the banking sector. In total the exposure of banks to conduit commercial paper financing was substantial.

Acharya & Richardson [2009] document, using Bankscope data, total conduit commercial paper outstanding in January 1987 for the ten largest conduit administrators as \$473 billion. Others have estimated the total asset backed commercial paper market outstanding at slightly above \$1 trillion. The subsequent contraction of the asset backed commercial paper market is distorted inasmuch as a number of banks chose to hold this paper after calls on the conduit liquidity facility. By any reckoning this was a material amount of liquidity for the banks collectively to find.

Guarantees are a primitive derivative which we will now examine theoretically. Box 5 outlines a simple framework due to Holmstrom & Tirole, which makes evident a number of relevant issues, including the potential failure of market-based finance-as-you-go strategies.

The guarantors of liquidity for the bank conduits were exposed to precisely the situation modelled, which was compounded by concerns over the declining value of conduit assets.³⁷ By the summer of 2007, as is widely documented elsewhere,³⁸ there was evidence of a marked deterioration in the performance of mortgage securities; default rates in the sub-prime sector had risen and were continuing to increase.³⁹ In addition, the market performance of asset-backed securities indices was showing marked deterioration from February 2007 forward—the ABX indices are most widely cited in this context.⁴⁰ By any reckoning, it was becoming obvious that investors had reason to be concerned; the uncertainty and risk of this asset type had increased and were still rising, and were further compounded by the relative opacity of conduit and CDO structures with respect to the quality and diversity of assets underlying them.

35 - It is arguable that this creation of a 'shadow' banking system was evasion rather than avoidance; particularly in light of the fact that reputation risk led the banks to take the assets and liabilities of these vehicles back on balance sheet even where there was no legal obligation to do so.

36 - Citibank, for example, bought back \$25 billion of mortgage-backed CDOs which were subsequently valued at 33%. HSBC reported bringing \$41 billion of SIV assets back on to its balance sheet. There are now new rules which require a bank to account for these vehicles as if they were assets of the bank and the Basel Committee are proposing a five-fold increase in the regulatory capital required by a guarantor bank for this exposure.

37 - Kiyotake & Moore [1997] develop a model in which collateral asset values serve as the mechanism for contagion—a theme which is central to this paper.

38 - See, for example, Demanyuk Y. & Van Hemert O. [2008], who find that the quality of loans deteriorated for six consecutive years before the crisis and that securitisers were to some extent aware of it.

39 - In addition to concerns over the quality of mortgage origination, which led to the NINJA ("no income, no job or assets") and "liar loan" epithets, questions were also being raised as to the soundness of some of the risk management techniques. The practice had emerged of offering 2/28 mortgages to sub-prime borrowers, which was grounded in the fear that 30-year fixed for this borrower classification was too risky for the mortgage lender. The 2/28 mortgage is often called a "band aid" loan structured with the first two years fixed at an initial low interest rate with the remaining twenty-eight years adjustable, usually every six months, at increasing, often dramatic, rates. In other words, this 2/28 structure arose in order to shift risk from the mortgage lender to the consumer, notwithstanding the fact that this was originally motivated by the riskiness of that consumer over time to the lender. This risk 'solution' introduces a specific path dependency into the consumer's mortgage servicing requirements, the need to refinance or face much higher interest costs after the initial two years have elapsed. The argument that continually rising house prices facilitated refinancing is, though logically true, spurious; thirty-year fixed mortgages would also have benefited and been more secure. This is a risk transfer which exacerbated rather than resolved the original position.

40 - The ABX indices, which were first created in January 2006, are a strong candidate as the initiator of the market meltdown. They aggregated information on the parlous state of delinquency of recent vintages of sub-prime mortgages and rendered this common knowledge. They also greatly facilitated short-selling of sub-prime mortgage securities as contracts could be written upon them for cash settlement (indices lower the asymmetric information "lemons" problem that would restrict transactions in individual mortgage securities). Their observed poor performance in the early part of 2007 was widely criticised as exceeding fundamental default and delinquency experience. However, the limited historic experience and the fact that under unlimited short-selling no equilibrium is defined would suggest that this poor performance was both possible and perhaps even likely.

Box 6 – Haircuts

Occasionally these are just the standard supervisory haircuts set by the Central Bank or under Basel II. As there is evidence that these levels feed into market practices, we shall discuss this aspect more fully later. Volatility-based measures, such as Value-at-Risk and stress tests, together with qualitative measures, are often employed in their determination. However, market forces and business interests are a significant qualitative determinant and in normal times can often override risk management concerns. This is merely a variant to the convention that in markets participants ignore some uncertainty and inherent risk in order to pursue the gains from trade.

In recent times daily or even intra-day collateral calls on repo have been introduced, harmonising them with OTC derivatives practices. Higher haircuts are usually restricted to renewals, other than in the case of specific contingency occurrences. With OTC derivatives, it is possible to receive demands based upon the variation of the contract value, and also on both variation in the value of collateral already posted and on the change in 'haircut' when a particular security becomes less attractive to the creditor in the contract. For example, a rating downgrade for an asset posted could even lead to it becoming entirely ineligible. Market illiquidity and uncertainty are usually prominent concerns when determining the 'haircut'.

OTC Derivatives Haircuts

Collateral agreements for OTC derivatives transactions are usually arranged under the International Swaps and Derivatives Association (ISDA) Master Agreement and related Credit Support Annex (CSA). The agreement covers threshold amounts and minimum transfers as well as the definition of eligible collateral, frequency of calls and calculation of exposures. The CSA often sets the collateralisation terms that apply to the entire portfolio of OTC derivatives outstanding between two parties. It is unusual for individual trades to be margined on a stand-alone basis.

The BIS Committee for the Global Financial System reports in its paper number 36: *'To reduce counterparty risk, standards in the OTC derivatives market are now moving towards the use of two-way collateral transfer agreements, daily re-margining practices and zero threshold amounts...Collateral criteria for OTC derivatives trades did not change during the crisis, perhaps because the renegotiation and modification of CSAs is quite a time-consuming process. Cash dominates the collateral received (constituting roughly 85%). The remainder is mostly made up of government bonds or other highly rated bonds with appropriate haircuts, and its composition and haircuts have remained broadly unchanged.'*

Collateral security margins for derivatives are usually based upon current exposures calculated on the basis of market prices and agreed models. In some cases these collateral agreements include further requirements based upon the potential future exposure of the contract.

CCP Margins

Central counterparties (CCPs), the clearing houses for exchange-traded derivatives, operate risk-based initial and variation margin systems. An initial margin based upon the volatility and possible worst case liquidation value is required. In addition, variation margins must be maintained and are derived from mark-to-market or model changes in value. The amount of collateral which must be posted is calculated on the basis of the total risk exposure of a counterparty's portfolio of contracts. This involves cross-margining, where the risks of different contracts are offset. Margins required are usually calculated on a daily basis, but sometimes intra-day; the right to make intra-day calls is reserved by most CCPs. Margin requirements are calculated on the basis of short periods to liquidation, usually just a few days; a worst case liquidation. This is usually materially less than the potential future exposure of most OTC derivatives contracts.

3. Haircuts

The techniques and processes, which usually include both quantitative and qualitative criteria, used to establish haircuts and set other credit terms are described in box 6, which also discusses some issues concerning the manner in which they are set in markets. Of course, central banks also apply haircuts to the collateral securities offered to them at the discount window.⁴¹

Gorton & Metrick [2009] in 'Securitized Banking and the Run on Repo' develop an index of the haircuts applied to securities in repo; this rises from zero prior to the summer of 2007 to 45% by early 2009. The effect of such rises in haircuts is to lower liquidity substantially.

41 - See http://www.frbdiscountwindow.org/20090819/margins_announcement.cfm?hdrID=14 for details of the securities currently acceptable in the US and their associated collateral margins (or haircuts).

Banks which had previously been financing themselves adequately could now only raise far lower cash amounts using their asset portfolios. In fact, such haircuts place restrictions upon the liability structure of banks; in the event that a bank can raise only 55% of its asset value from money markets, then capital and unsecured liabilities must equate to the balance of 45%. The problem for a bank is how it increases unsecured deposits or raises other capital to finance the reduction in liquidity at a time when its assets are pledged elsewhere.

When a security has badly impaired value as collateral due to the haircuts being applied in repo, the obvious solution is to sell the security in the market, with the expected consequence for market prices.⁴² Table 2 (below)⁴³ shows the changes in haircuts between June 2007 and June 2009 by type of security and type of counterparty. Over this period, several classes of asset ceased to have any value as collateral for repo, notably structured products and asset-backed securities. High grade securities such as US government and agency securities saw far lower increases in haircuts but nonetheless did see increases. It is interesting to note that the haircuts for equities increased only marginally over this period.⁴⁴ This is surprising given that not only did equity prices decline for prolonged periods but also equity market volatility increased to unprecedented levels—the VIX volatility index peaked at over 90% in intraday trading in the wake of the bankruptcy of Lehman Brothers. At the end of June 2007 the index close value was 15.4% and at the end of June 2009 it closed at 26.2%. This suggests rather strongly that volatility is not the prime determinant of haircuts in practice—and is in accord with one of the CGFS (Committee for the Global Financial System) survey findings, reported later, in that regard.

Table 2: Typical haircuts at June 2007 and June 2009 (%)

	June 2007			June 2009		
	Prime ¹	Non-prime ²	Unrated ³	Prime ¹	Non-prime ²	Unrated ³
G7 government bonds						
Short-term	0	0	0.5	0.5	1	2
Medium-term	0	0	0.5	1	2	3
US Agencies						
Short-term	1	2	3	1	2	3
Medium-term	1	2	3	2	5	7
Pfandbrief						
Prime MBS						
AAA-rated	4	6	10	10	20	30-100
AA- and A-rated	8	12	25	100	100	100
Asset-backed securities	10	20	20	25	50	100
Structured products (AAA)	10	15	20	100	100	100
Investment grade bonds						
AAA- and AA-rated	1	2	5	8	12	15
A- and BBB-rated	4	7	10	10	15	20
High-yield bonds	8	12	20	15	20	40
Equity						
G7 countries	10	12	20	15	20	25
Emerging economies	15	20	35	20	25	40

¹Prime counterparty ²Non-prime counterparty ³Hedge funds and other unrated counterparties

It is obvious from these changes in haircuts that any financial institution which was reliant upon funding in the repo market would have suffered a considerable liquidity squeeze from this source alone. The distinction between prime and non-prime counterparties in table 2 provides an indication of the possible magnitude of the market practice of demanding increased collateral upon counterparty downgrade as the haircuts increase materially. This practice is also widely used with respect to derivatives exposures, where it is sometimes referred to as a 'cliff effect'.

42 - It should be recognised that if a security cannot be repo'd, then it will be difficult, and perhaps impossible to sell since the dealer also has a need to finance the purchase.

43 - Reproduced from the BIS Committee for the Global Financial System (CGFS) paper number 36 [2010] 'The role of margin requirements and haircuts in procyclicality'

44 - Issues of market microstructure also enter into consideration. Eligibility of an asset for discount window borrowings would tend to view official haircuts as an arbitrage value in the absence of 'stigma' limiting such borrowings. Equity markets, where many outside money investors are present and dealer inventory is not significant, should show some resilience.

The theory notwithstanding, the CGFS reported in its paper: 'Increased volatility of market prices also contributed to greater haircuts, though participants in some markets said that it did not contribute materially. Portfolio margining models, often used in prime brokerage, might have been expected to generate volatile margins that responded to changes in market volatility and correlation. However, the majority of such models appear to have used volatility assumptions backed out from historical stressed periods rather than the most recent data so that, for more liquid asset classes such as G7 government bonds and equities, haircuts changed only modestly.'

The potential exists that segmentation of market participants, including central banks, contributes to or even places explicit bounds on the haircuts applied in market practice—there is no reason, other than the possibility of some form of market stigma, for a bank to accept a higher haircut in markets than would be applied at the discount window. This aspect is a topic worthy of further empirical research.

4. The Derivatives Market

In this section we seek to describe the derivatives markets⁴⁵ and give some indication of their development over the past decade.

The market is overwhelmingly OTC in nature—in 1999 exchange-traded derivatives accounted for just 11% of notional exposures, declining in 2004 to 8% and, by 2009, falling to less than 5% of activity.⁴⁶ The overall market has grown impressively—the total notional outstanding contracts of US banks have risen from \$33 trillion in 1999 to \$81 trillion in 2004 and then to \$203 trillion in 2009—that is approaching 20% p.a. compound. Of course this notional contract figure does not reflect well the risk exposures associated with these contracts, to which we shall return later. The types of derivative contract are shown below as table 3.

Table 3: Market shares by contract type

	1999	2004	2009
Futures	27%	13%	12%
Swaps	51%	64%	67%
Options	21%	20%	15%
Credit	1%	3%	7%

Notional derivatives contracts outstanding may also be categorised by market risk, as is shown below as table 4.

Table 4: Derivatives by market

	1999	2004	2009
Interest rate	79%	87%	84%
Foreign exchange	17%	10%	8%
Equities	2%	1%	1%
Commodities	0%	0%	0%
Credit derivatives	1%	1%	7%

The derivatives market is highly concentrated. In 1999 the top seven US banks, in OCC data, accounted for 93% of derivatives exposures rising to 96% in 2004 and after the restructuring, mergers and takeovers of the investment banks in the crisis, the five most prominent US banks now account for 97% of all activity. This degree of concentration should be cause for concern in its own right.⁴⁷

45 - We use predominantly the OCC (Office of the Comptroller of the Currency) quarterly derivatives reports for US commercial banks and focus upon quarter ended June reports as these are less prone to year-end 'window-dressing' and other effects arising from consideration of trader compensation schemes.

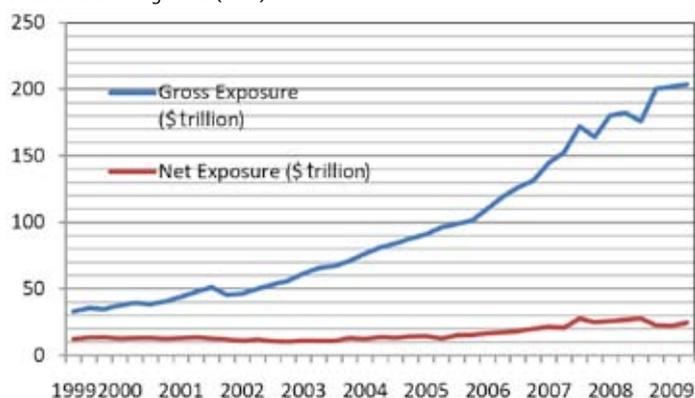
46 - It should be emphasised that this is a relative figure which implies only that the growth in exchange-traded (ET) activity has not kept pace with that of OTC derivatives—but unsurprising as most new products, such as credit derivatives, are developed first in the OTC markets. It appears that ET activity is to a very large extent driven by the hedging of OTC contracts. The exchange-traded product might be characterised as 'mature'. In fact this is a net figure as contracts are 'torn-up' daily. It is the first of many discrepancies in data consistency.

47 - Tri-party repo is also highly concentrated in both supply and demand for funds.

The overall derivatives market was estimated by the Bank for International Settlements (BIS) to be greater than \$600 trillion notional in 2009. The OCC data now capture approximately one third of this. There is some evidence that the US banks' share of the OTC derivatives markets may have declined marginally in the decade considered. In the period prior to the crisis the share of the overall market captured by the OCC data was smaller than currently as the US investment banks had been major participants in these markets. From the published data it is not possible to estimate fully the magnitude of these effects; by integrating two banks their mutual, bilateral exposures will be extinguished, apparently shrinking the overall market size. In the case of the merger of JP Morgan and Chase, the result was a quarterly decline in gross market size of \$5.9 trillion, which consisted of a decrease of \$6.9 trillion for the merged firm and an increase in the rest of the market of \$1 trillion. This also illustrates one of the problems of measurement of market size using notional contract outstandings as the metric.

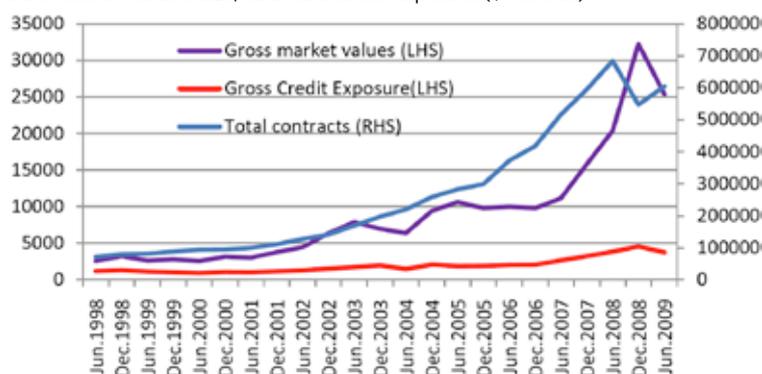
The OCC reports the level of 'netting'⁴⁸ applicable to notional contracts as 64% of contracts in 1999 rising to 83% in 2004 and to 88% in 2009. It now exceeds 90% in the latest OCC releases. If this is considered a fair measure of the market then true notional exposures are reduced to \$11.8 trillion in 1999, \$13.8 trillion in 2004 and \$24.6 trillion in 2009.⁴⁹ These are far less intimidating figures than the gross numbers which are so widely reported, but, nonetheless, they are large relative to the capital base of the US banking industry (\$1.0 trillion). Figure 1 shows the evolution of total gross and net notional exposures over the period June 1999 to June 2009:

Figure 1: Gross and net derivatives outstanding – US (OCC)



The OCC publication also reports the credit equivalents of derivatives contracts outstanding.⁵⁰ In this it follows the market practice of considering the current mark-to-market net exposure of the banks.

Figure 2: BIS Estimates of OTC derivatives markets size, value and credit exposure. (\$ millions)



48 - This 'netting' should not be confused with 'trade compression', which consists of finding offsetting transactions within the banks' portfolios, which may then be negated and no longer appear in published statistics. Theo Lubke of the NY Fed recently reported that \$53 trillion notional of CDS contracts and \$39 trillion notional of interest rate swaps had been compressed since 2008.

49 - This residual figure, however, is, perhaps, something of an overstatement since, among these netted gross figures, there may be many offsetting but unnetted transactions. If the banking books were perfectly hedged, this would justify halving these figures again.

50 - Methodological differences can produce very large discrepancies in the reported OTC derivatives statistics. Figure 2 shows the BIS global figures as at June 2009. Though three times the gross notional size of the US market, this shows the global net market value outstandings as being similar in size to the estimated US market above. Even if the US market net figure is halved, this would suggest an overall market of around \$36 trillion rather than the \$25 trillion reported by the BIS. As this BIS figure is arrived at by netting the entire reported positive and negative gross market values of 'reporting' banks, this BIS figure is perhaps better considered as a measure of the non-bank use of derivatives; in that view, of use by corporations and non-bank financial companies is indeed substantial. The figure reported for total credit exposure is not surprising; a global figure of \$3.74 trillion is similar to the US exposure of £1.2 trillion rescaled, but this is discussed further later.

The detail available from the OCC surveys allows us to continue with further analysis than is possible with the BIS statistics; accordingly, in this note we use the OCC data. There are some discrepancies between these two publications, notably in the size of the net market discussed previously, and also the net credit exposure. The BIS credit calculation is based upon netting positive and negative exposures at a high level. Though there is apparent agreement between the OCC reported figure of \$1.2 trillion and the BIS \$3.74 trillion global market estimate, in the case of the OCC statistics, this includes the potential future exposure. Net current credit exposure reported by the OCC is just \$555 billion, which would suggest a global market exposure of around \$1.6 trillion rather than the \$3.74 trillion reported by the BIS.

5. Credit Exposure Calculations⁵¹

The first step in estimating the credit exposure of derivatives is the estimation of the fair value of all contracts which are receivables for the bank (gross positive fair value). Simultaneously those contracts which are 'out-of-the money' are estimated, again using fair value techniques. In the OCC surveys, for those contracts where a netting agreement or right of offset with the counterparty exists, the gross positive exposures are netted to produce a 'net current credit exposure' (NCCE). The table below illustrates this process:

Table 5: Credit exposure calculations

\$ Billion	Q209	Q109
Gross Positive Fair Value	4,641	6,325
Less Netting Benefit	4,086	5,630
Netted Current Credit Exposure	555	695
Plus Potential Future Exposure	670	723
Total Credit Exposure	1,225	1,418
Netting Benefit %	88.0%	89.0%

It is worth noting that, in the second quarter of 2009, the gross negative fair values of the banks' positions amounted to \$4.772 trillion.⁵² The non-derivative total assets of the banks amounted to just \$10.415 trillion.

The second calculation is an estimation of the degree to which the derivative may move in favour of the bank over the life of the contract, the potential future exposure (PFE).⁵³ This calculation is similar to the basis on which initial margins⁵⁴ for exchange-traded derivatives are set; it is an estimate of the replacement, or equivalent 'close out', cost of the contract at future dates. The prime determinant here is the volatility of the contract and that is a function of both market behaviour and contract terms.

The significance of these derivatives exposures and their evolution may be illustrated by considering the ratio of net current credit exposure to risk-based capital for these banks. This is reported in 1999 as averaging 294% among the top eight banks versus an industry average of just 6.9%, in 2004 this was 247% for the top seven banks with the industry average at just 4.9% and in 2009, 207% for the top five. In the early periods JP Morgan stood out as having a very high level of exposure, exceeding 750% on a number of occasions. In the 2009 sample, Goldman Sachs stands out with a ratio of 921%; omitting Goldman the simple average among the top four was 175% of risk-based capital. Another possible comparator is the amount of commercial and industrial loans held by the US banking system—in 2007 this amounted to \$1.3 trillion and perhaps surprisingly had risen above \$1.5 trillion during 2008,⁵⁵ but has declined markedly to \$1.25 trillion in recent releases.⁵⁶

51 - Credit risk in derivatives differs from that experienced in traditional banking, where the bank's maximum exposure is limited to the amount of the loan advanced, the bank's asset. By contrast, a derivative, such as a swap, may be either an asset or a liability depending upon the terms of the contract and the state of the market in the underlying. The credit exposure of an option arises from the degree to which it is in the money and its terms—the degree of exposure to the counterparty. The credit risk of a derivative is an estimate, usually derived from a model.

52 - This is a sum which the banks could hardly meet from their own resources and could be considered *prima facie* evidence of overtrading.

53 - It should also be noted that the OCC changed the method of calculation of PFE in the second quarter of 2007, now using methods developed by the banks rather than a simple add-on method. The result was that a PFE calculated previously as \$1.659 trillion was reduced to just \$734 billion under the new method. In the analysis which follows we use the original reported calculations and adjust upwards the subsequently reported PFE values by this factor.

54 - One of the problems for central counterparties in clearing non-standardised contracts lies precisely in the estimation of the initial margin required.

55 - This increase can in fact be attributed to companies drawing down their committed lines of credit.

56 - Federal Reserve H8 report.

The practice of taking collateral security against credit exposures arising from derivatives contracts has grown substantially over the last decade but before considering collateral security in some detail, it is worth considering the type of collateral that is posted against derivatives exposures (table 6):

Table 6: Collateral security composition for OTC derivatives. (Source: OCC-2009)

Fair Value of Collateral	Cash US Dollar	Cash Other	US Treasury Securities	US Gov't Agency	Corp Bonds	Equity Securities	All Other Collateral	Total
Collateral Composition	61.4%	22.9%	1.3%	3.2%	0.3%	1.3%	9.6%	100%

The CGFS reported some 85% of collateral posted as security is cash.⁵⁷ In 2009, the OCC reports that total netted current credit exposure amounted to \$555 billion of which 63% was collateralised (\$343 billion). The collateral held by the top five banks amounts to 90% of their netted current credit exposure; at \$432 billion, the collateral held by these banks exceeds the total held by all banks, which lends support to the argument that these banks have market power. Table 7 shows the composition of total credit exposure from derivatives, the bilaterally netted current credit exposure and the potential future exposure.

Table 7: Credit exposures and collateral posted in June 2009. The PFE values reported here are calculated according to the new method. (Source: OCC)

\$ Millions	Total Assets	Total Notional	Risk-Based Capital	Netted Current	PFE*	Total Credit Exposure	Collateral
JPM CHASE	1,663,998	79,941,219	142,825	165,044	239,116	404,160	107,000
GOLDMAN SACHS	119,678	40,477,262	20,191	115,739	70,250	185,989	171,000
BANK AMERICA	1,450,830	39,064,884	137,630	61,669	126,654	188,324	84,000
CITIBANK	1,165,400	31,943,721	112,475	84,425	150,805	235,230	58,000
WELLS FARGO	1,100,177	5,111,215	117,660	51,299	32,497	83,796	12,000
Totals	5,500,083	196,538,301	530,781	478,176	619,322	1,097,499	432,000

It is worth examining the post collateral total credit exposure of these banks as a proportion of their risk-based capital; these figures are shown below as Table 8. The total asset exposure as a proportion of risk based capital is also shown. Unfortunately, we know nothing of the quality or riskiness of these non-derivative assets, or any specific security collateral supporting them.

Table 8: Authors' calculations - Source OCC

	Unsecured Total Credit Exposure / proportion of risk-based capital	Total Other Assets / Risk-based Capital
JPM CHASE	208%	1165%
GOLDMAN SACHS	74%	593%
BANK AMERICA	76%	1054%
CITIBANK	158%	1036%
WELLS FARGO	61%	935%

The banks report derivatives not held for trading as being consistently in the range 2% - 3% of total outstanding derivatives contracts overall. This suggests strongly that though they may play an important role in the financial risk management of banks, this is not material in the context of overall market activity.

Table 9: Derivatives held for trading and other purposes: June 2009 OCC

Rank	Bank	Total Assets	Total Derivatives	Trading		Not For Trading		Credit Derivatives	
				Gross positive Fair Value	Gross negative Fair Value	Gross positive Fair Value	Gross negative Fair Value	Gross positive Fair Value	Gross negative Fair Value
1	JP Morgan Chase	1.663	79.941	1.485	1.459	0.0027	0.0012	0.296	0.285
2	Goldman Sachs	0.119	40.477	0.673	0.616	0.0005	0	0.091	0.081
3	Bank of America	1.451	39.065	0.899	0.879	0.0008	0.0039	0.081	0.076
4	Citibank	1.165	31.944	0.691	0.684	0.0037	0.0073	0.139	0.123
5	Wells Fargo	1.101	5.111	0.087	0.085	0.0125	0.0104	0.02	0.02
Top 5		5.501	196.538	3.835	3.724	0.0204	0.0194	0.628	0.584
Other		4.916	6.922	0.106	0.104	0.0126	0.0101	0.039	0.034
Total		10.415	203.438	3.942	3.828	0.0329	0.0329	0.666	0.628

From table 9 it is evident that, other than in the case of Wells Fargo, the use of derivatives by banks for their own risk management is extremely limited. Whilst it would be expected that balance sheet hedging activities should carry a cost, only Citibank reports a net cost associated with not-for-trading exposures. Other commercial banks report just \$12 billion of gross positive fair value and \$10 billion of gross negative fair value. It is difficult to reconcile this low exposure with the reported fact that banks account for more than 50% of counterparty derivatives exposures.

The exposure of the large reporting banks can also be classified more fully by type of user, as is shown in table 10:

Table 10: Net current credit exposure by type of counterparty. Source: OCC 2009

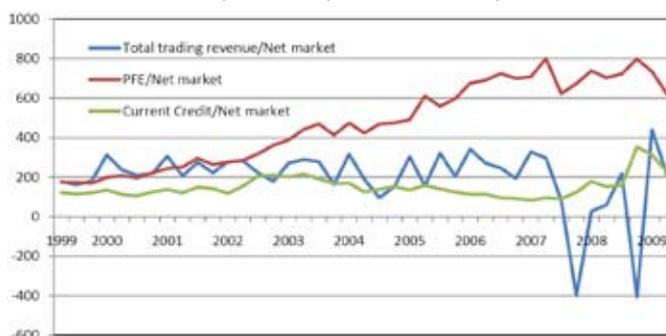
Net Current Credit Exposure (\$ Billion)	Banks	Mono-line Insurers	Hedge Funds	Sovereign	Corporate & Other	All Counterparties
JPM Chase	86.96	0.69	3.76	3.95	69.17	164.53
Bank of America	57.28	9.95	2.57	3.79	87.17	160.77
Goldman Sachs	158.38	0.00	5.03	5.14	50.10	218.65
Morgan Stanley	63.77	6.48	2.04	8.18	51.28	131.75
Citigroup	75.29	4.87	3.11	2.47	46.00	131.73
Wells Fargo	13.02	1.30	1.48	0.01	15.91	31.72
Total—All Banks	472.73	25.78	19.06	24.45	343.54	885.57

It is clear from table 10 that corporate and other use is substantial. Unfortunately, we have been unable to obtain data on the relative levels of collateral provision by classification for these counterparties. However, the fourth quarter 2009 OCC call report observes that banks now hold collateral against 95% of their current bank exposures and 217% of their hedge fund exposures, with corporate and sovereigns providing much less. The over-collateralisation of any classification carries the consequence that the simple proportion of aggregate exposures collateralised may mislead when used as an indicator of true bank exposure.

The use of derivatives by banks is profitable for them in aggregate, both as users for their own risk management and as traders in derivatives instruments. Losses reported as write-offs and in mark-to-market valuation are small and rare relative to the exposures and profitability of positions shown. Write-offs exceed \$150 billion only in four crisis years, and even then are contained far below 1998's \$850 billion. This raises questions as to whether the profitability arises from market developments since contract execution or is at the expense of non-bank counterparties.

Next we consider the question of profitability and market credit exposures. As the market has grown substantially over the period in question, we analyse the profitability and credit exposures rescaled by the net market size, which facilitates comparisons. Figure 3 shows the rescaled series for net current credit exposure, potential future exposure and reported profits.

Figure 3: Rescaled reported profits, net current credit exposure and potential future exposure—Authors' calculations, OCC data



The first and most obvious point to note from figure 3 is that, other than during the recent turmoil, reported profitability has been stable, though with some oscillation from period to period. There is also some evidence here that, from a high in 2003, net current credit exposure had been declining in the run-up to 2007. This might be interpreted as the banks taking profits at the expense of maintaining mark-to-market credit exposures or unrealised profits. This is perhaps a manifestation of moral hazard, of bankers' rent-seeking behaviour.

The most startling development evident though, is that the potential future exposure almost quadruples over this period without being reflected in either reported profitability or an increase in current mark-to-market exposure. It should be remembered that the potential future exposure is that of contracts which are currently 'in the money', that is, which have a positive current net credit exposure. The contracts which are currently liabilities have a similar, though negative potential future exposure. These constitute a material barrier to exit,⁵⁸ in a manner which is very similar to insurance liabilities.

The growth of potential future exposure is problematic in an accounting context; it suggests that, rather than using mark-to-market valuation to determine profits reported, the concepts of earned premium and provisions should be introduced. This mark-to-market accounting is also the mechanism by which required collateral is calculated, transforming change in counterparty credit exposure into immediate collateral or liquidity demands. As this change is originally rooted in a change in market value of the underlying, or some other market-consistent parametric determinant of contract value, this process is profoundly myopic—it takes unrealised changes in market values, caused by other marginal trading, and translates then into immediate requirements for collateral or liquidity. One implicit assumption in this activity is that market prices are always correct in some sense. The process also introduces path dependency into the liquidity and collateral management process.

It is also evident that derivatives activity accounts for a significant proportion of the total assets of the major banks. Table 11 below shows this for the top five banks:

Table 11: Current derivatives net credit exposure as a proportion of group total assets. (Authors' calculations, OCC data – June 2009)

	Derivatives Credit Exposure as proportion of group total assets
JPM CHASE	19.9%
GOLDMAN SACHS	20.9%
BANK AMERICA	8.3%
CITIBANK	12.7%
WELLS FARGO	6.5%

58 - One of the simplest ways of distinguishing insurance from banking is that with insurance the barriers to exit are higher than the barriers to entry. Another is to consider banks as transforming liquid liabilities into illiquid assets while insurance is a transformation of illiquid liabilities into liquid assets. The term of OTC derivative contracts is often quite long, for example, over 20% of interest rate swaps are longer than five years in remaining term. This implies that resolution of a failed bank is likely to be a lengthy process of 'run-off', and that alone, perhaps, justifies the proposed creation of 'living wills'.

6. Evidence of Collateral Shortages

There are a number of indicators of shortages of collateral which may be considered in the context of the crisis. The first is a decrease in re-hypothecation of securities received as collateral. Singh & Aitken [2009] document a decline of \$1.8 trillion for the four broker-dealers in their study. The second is an increase in the Treasury repo 'fail' rate.⁵⁹ Total fails in the period since the Federal Reserve began collecting data averaged less than \$170 billion per week. In October 2008 these fails reached a high of \$5.1 trillion.

7. Central Counterparties (CCPs)

The reasons stated by officials in both Europe and the US for the proposed requirement to use central counterparties for derivatives clearing are the problems of concentration and interconnectedness of the banking system. CCPs are being proposed as a mechanism which breaks the chain of causal dependency among banks with derivatives activities.

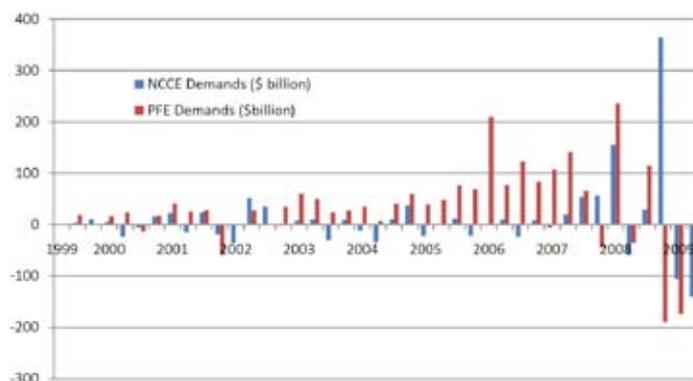
Interconnectedness is of course a property of any distribution system. The remedy proposed, in fact, concentrates the dependency and that is acceptable only if the CCP is highly resilient—and to achieve that it is necessary for it to hold substantial default funds derived from the initial margin. The optimal network solution for resilience, by contrast, would be one in which all participants held equal, uniform exposures.

In our subsequent discussion of CCPs the detail of CCP practices and organisation are not considered. However, it should be recognised that these differ greatly—the thirteen CCPs in Europe vary widely in their financial structure, margin and default management processes. There are two further issues which should be of concern—the prospect of CCPs competing on the basis of risk pricing, which some claim is evident, and unresolved issues of client margin financing by clearing member banks.

8. CCPs and Collateral

CCPs can be expected to operate strict margining regimes, with daily variation margin being applied in addition to an initial margin. In figure 4 we consider the possible magnitude of margin calls under such a regime.⁶⁰ We examine calls arising from movements in the net current credit exposure (variation margin) and from potential future exposure (initial margin). The lack of any obvious relation between net current credit exposure and the potential future exposure is perhaps surprising. It is also immediately evident that the collateral calls arising from changes in the net current credit exposure of derivatives are material in the context of both the overall capital and the overall assets of the reporting banks.⁶¹

Figure 4: Potential collateral calls arising from changes in net current credit exposure (NCCE) and from changes in the full potential future exposure. (Author's calculations—OCC data)



59 - A repo 'fail' occurs when the counterparty cannot find the security needed to be returned—usually, of course this occurs because the security has been re-hypothecated, perhaps several times. A repo 'fail' is not an event of default in standard practice.

60 - The 2010 BIS Committee on Payment and Settlement Systems Committee consultative report on 'Considerations for Trade Repositories in OTC derivatives markets', though listing twelve relevant factors for them, does not extend to liquidity issues.

61 - While CCPs operate daily margin calls, the figures cited are here quarterly. However, the CCP would have to make calls aggregating to these figures over the period. Moreover, the nature of financial markets is such that the majority of major market movements are concentrated in a very small number of days.

We observe a single ninety-day period (Q4 2008) in which 35% of the entire banking system's capital could have been called as collateral; a transfer of wealth among banks and other counterparties on this scale is unprecedented. A central counterparty can be expected to maintain rigorous margining practices, making such calls.

The daily variation margin is, of course, available for withdrawal by those counterparties in credit. However, for this to be an efficient form of transfer, highly efficient systems⁶² will be required. There is a potential problem with late margin payments⁶³ making funds unavailable for redistribution; particularly when the collateral delivered takes the form of securities and the bank making the withdrawal expects cash.

The PFE calculations shown in figure 4 are simply the change from period to period in the PFE amount reported. This may be criticised on several grounds, notably the tenor(s) involved, as a level of possible initial margin. However, there have been three occasions in the past twelve years on which derivatives losses amounted to more than \$350 billion in a quarter; any CCP operating a risk-based margining system can be expected, in prudence, to demand at least this initial margin collateral from each counterparty.

An alternative would be to base the initial margin on the volatility of either the NCCE or the PFE. The standard deviation of the NCCE series is \$73 billion and the standard deviation of the PFE series is \$81 billion—so a two standard deviation coverage, which is perhaps inadequate, would amount to either \$146 billion or \$162 billion, respectively, and again would be demanded of both counterparties.

It is clear that the central counterparty would have difficulty valuing large portfolios of non-standardised derivatives contracts, and equally could not be expected to liquidate material proportions of the net market at very short notice.⁶⁴ Concentration risk is a serious concern here, and the derivatives market is highly concentrated.

The CCP is likely therefore to hold very substantial amounts of margin liquidity; this is liquidity removed from the banking system and then re-deposited by the CCP. Of course, the CCP cannot be expected to deposit funds with any bank which is deemed to be of too low a credit standing. It seems therefore that the CCP solution to derivatives concentrates rather than disperses the liquidity problem of derivatives collateralisation.

9. Contagion

The question of contagion among banks has been widely discussed and analysed in the wake of the crisis. Overwhelmingly, this literature considers market mechanisms for transmission—in this paper we have proposed that collateral or equivalently liquidity may be the medium for immediate transmission. We have given indications of the magnitudes of demands for liquidity arising from changes in repo haircuts, the breakdown of securitisation conduits and collateral calls under credit support agreements to OTC derivatives. It is clear that each of these is large by comparison with the stock of liquidity required for payments system maintenance. We will discuss later the effect of collateral and haircuts on liquidity supply and demand in a macroeconomic context.

We are not concerned with the identification of the initiation of crisis, but rather its propagation and possible amplification. It certainly appears that the performance of sub-prime mortgages was the proximate cause, but the magnitude of the subsequent reactions of market prices and banks more generally still requires explanation. The question of market breakdown has, since Keynes at least, been seen as a breakdown of the convention that participants ignore some uncertainty and

62 - The computational and system requirements for modelling non-standardised derivatives contracts and operating a real-time securities custody and payments system are far from trivial.

63 - This point is noted in the Technical Notes to the IMF's Financial Sector Assessment Program of the US (May 2010): 'Steps are needed to amend Fedwire's settlement procedures for tri-party repo transactions, Depository Trust Company (DTC), and Clearing House Interbank Payments System (CHIPS) to discourage late in the date payments'. These reports are the best comparative analysis available of securities and payments settlement systems arrangements. These issues are also relevant, as noted elsewhere, in consideration of the extent to which flow movements result in demand for liquidity stock.

64 - Lo [2010] makes this valuation point, rather more forcefully.

risk in order to pursue the gains from trade in markets. Morris & Shin [2010] develop a model, which draws upon insights from game theory and common knowledge in particular, where such initiation and contagion may occur.⁶⁵ They note a useful role for accounting standards and credit ratings in generating shared understanding and that attempts to increase transparency may undermine this.

Our hypothesis is that the banks involved in both traditional banking and the extensive provision of risk management services and products have internalised one possible route for contagion. Shocks experienced in the risk arena, which are to be expected given the insurance-like nature⁶⁶ of this activity,⁶⁷ may be transmitted to their traditional banking activities and from that to other banks not extensively involved in these activities. This is inherently a highly unstable situation; far more so than the classical fragility of banks arising simply from maturity transform.

The collateral mechanism is central in this context. Collateral's role as a supplement to outside money based liquidity stock is key in a world where the liquidity stock can be shown theoretically to be inadequate. Its action is to translate unrealised losses into immediate liquidity demands. The process shortens the effective horizon of a contract. Notwithstanding the fact that the crystallisation of credit risk in a loan default occurs in the future, the collateral call is immediate.

The timing of liquidity needs differs between a derivative and a traditional loan; the demand arises immediately in the case of derivatives. With a loan the liquidity is exchanged at the time of advance and any shortage realised upon default; with a contingent derivative there is a liquidity stock shortfall at the time of exercise. Under a margining arrangement liquidity demands may arise at any point in the life of the derivative contract, but this prior funding is only to their current 'fair price'.

Box 7 – Dependency Unintended Consequences

The purpose of this box is to illustrate the concept of path dependence and its potential costs. A little more than three years ago, a UK industrial concern borrowed £100 million to finance its expansion and the construction of new manufacturing facilities; this was achieved by the issuance of a privately placed unsecured floating rate note bearing interest at Libor plus 5/8% for its twelve year term. The investment banking advisors to this transaction suggested that the elimination of the interest rate risk associated with the payment of Libor over this term was prudent; this was accepted and achieved through the completion of an interest rate swap under which the company paid a fixed rate of 5.5% per annum; the swap agreement conformed in outline to the standard ISDA form and contained a credit support agreement (CSA), under which cash collateral may be called from the company by the investment bank.

The ten-year swap rate declined to 4% earlier this year. This has resulted in a collateral margin call on the company of £12.2 million; as a result of poor current trading conditions, this is cash the company does not possess and must borrow from its bankers on the expensive terms which reflect the current economic and financial situation.

Though limiting the credit exposure of the investment bank, the use of collateral here has proved malign for the company and itself a material source of risk and cost. The result of the CSA, with its potential for cash calls prior to the maturity of the swap, is to shorten the effective term of the company's borrowing. One way of describing this situation is to say that the company is effectively being required to prepay some of its committed future interest rate payments. In fact, the procedure does more than this; the overall cost of this financing and the development of the balance sheet now depends upon the path of interest rates and their term structure over the life of the financing.

65 - They refer to their model structure as Rubinstein's email game meets Akerlof's lemons problem.

66 - A number of recent reports consider the insurance markets in the crisis and describe well the principal differences between banking and insurance. See for example: Geneva Report [2010] and OECD Report [2010] Financial guarantee insurance is identified as different from traditional insurance activities and potentially suspect in a financial stability context by both of these reports.

67 - It is worth noting that the Lloyd's market severely restricted the writing of financial guarantee insurance following the collapse of the Harrison syndicates in 1924 and that this persisted until 2000 – during this period exemption approvals were needed from the same committee that considered war risks. The relaxation of these restrictions followed after intense lobbying related to the development of more sophisticated alternative risk transfer 'solutions' – which of course may be viewed as insurance companies moving into the domain of structured finance occupied by investment banks.

We know that the ability to time actions is valuable and this is confirmed by elementary financial theory; for example, the price premium that American put options, which may be exercised at any point in their lifetime, exhibit over similar European options, which may be exercised only at expiration. More generally, it can be demonstrated that exposure to collateral calls, under adverse developments, carries a cost which is determined by the product of the likelihood-adjusted expected shortfall and the cost of borrowing these funds over the term of the contract. There is in fact much variation in the experienced cost and funding—the calculation described is merely the average experience. In addition, there is the potential for further costs, such as those which might arise from the higher leverage and restricted borrowing capacity of the company; *in extremis* this can even endanger other loan covenants.

Perhaps the most well-known of the unintended consequences of risk management interventions is the ratings-triggered credit support agreement, under which no collateral is demanded until the counterparty's credit rating is downgraded—a process which amounts to kicking a man when he is down, speeding the likelihood of serious injury and death.

The doctrine attributed to Bagehot that the central bank should supply liquidity to solvent banks against adequate collateral is appropriate where this enables continuance of the lending, liquidity redistribution, function and might extend in amount to all of the assets owned by the bank. In this world the role of the central bank is to offer liquidity insurance.⁶⁸ The supply of liquidity to meet collateral calls from derivatives, however, is a different concern. These cover losses incurred but not realised by the bank. At maximum therefore the central bank should limit its advances of liquidity for this purpose to the capital resources of the bank.

The exchange of liquidity in a collateral-secured situation may, from a stock standpoint, be viewed as less than complete. Unsecured interbank lending is complete transfer of liquidity. In the case of repo, if we consider the pathological case where cash is used as the collateral, we see that the net transfer is nil. Even when securities are used as collateral, the net transfer may be very small indeed if these securities are close substitutes⁶⁹ for outside money.

Collateral management can be seen as management of the consequence of a default. The event itself, counterparty default or contract exercise, is uncertain; however, for many contracts, and arguably most in the case of loans, it will not occur. It is clearly inefficient to be maintaining collateral margining arrangements for those contracts where default does not occur. In fact, the role of collateral can be seen as extinguishing credit exposure and reducing liquidity creation. The very act of collecting collateral weakens the bank upon which the demand is made, shortening the horizon to default. It also weakens the quality of other claims upon that bank.⁷⁰

Another source of inefficiency arising from this process lies in the implicit assumption that all movements of price of the underlying are founded in rational fundamentals. Obviously, to the extent that prices contain noise rather than information, then noise is crystallised. This problem is well known in the portfolio optimisation literature, where equally weighted portfolios are often observed to outperform estimated mean-variance 'optimal' portfolios. The equally weighted portfolio is free from noise (and also security information); it does not use any of the history of the securities.

There is also a criticism of the role of derivatives in completing markets associated with the hedging process. Derivatives may help to increase trade and exchange, a flow concept of liquidity, but they do so at a cost—if liquidity did not have a cost, all assets would be liquid. The criticism, however, does not arise from this aspect but from the collateral and hedging requirements of these contracts. These processes introduce new inefficiencies, path dependencies,⁷¹ into market price evolution. As

68 - The seigniorage associated with the provision of money by the central bank may be viewed as the premium associated with this insurance. Commercial banks also benefit from a form of seigniorage to the extent that they are creating inside or private money and capital adequacy rules can be viewed as limitations on this.

69 - For example: Treasury bills.

70 - This differs from the situation where a new liability is introduced, which dilutes the claims of other liability holders. Here, it is access to that bank's assets which is being impaired.

71 - There are two papers which cover well the concept of path dependency and its costs in the context of derivatives strategies: Cox J. & Leland [2002] and Vanduffel *et al.* [2007]. There is also a separate literature on path dependency which considers the way history may matter and phenomena such as 'lock-in' occur. This latter concept is usually illustrated by the case of Betamax and VHS, in which a technologically inferior product succeeded at the expense of the superior. It seems that research along these lines on the history of the derivatives markets might prove very informative.

this concept may be obscure to readers not familiar with options pricing and hedging techniques, box 7 expands this with some simple illustrations. There is a trade-off here between the efficiency gains arising from the market completion achieved by a derivative and the new inefficiencies introduced by its hedging.

Inasmuch as banks must hoard some liquidity as provision against their activities in risk management services on precautionary grounds,⁷² an aggregate liquidity shortage⁷³ will result and for the combined firm this will be reflected in sub-optimal traditional banking activity. As is evident from the sheer scale and variability of derivatives activity and exposures, these liquidity shortages may be very substantial relative to the capital resources of a bank and become systemically important. These claims can far exceed those amounts needed for payments system activities.⁷⁴ It is not at all obvious why a central bank should meet this form of liquidity shortage in the absence of cross-contamination of traditional banking activities.

Similarly a shock in the repo markets that results in higher haircuts being applied may restrict the ability of a bank to fund both its traditional banking activity and performance of its financial risk management services obligations.⁷⁵ For a stand-alone traditional bank, such liquidity shortages are not problematic; the central bank may supply the needed liquidity. However, it is evident that some investment banks, notably Bear Stearns, developed an over-reliance on the market,⁷⁶ funding more than 50% of their assets in short-term day-to-day 'repo' markets. The lessons of the simple theoretical model are particularly relevant as these investment banks did not, in the event of market failure, have access to the central bank as liquidity insurance.

For each bank suffering under a mark-to-market collateral call, there is a counterparty which gains. However, this counterparty should not be expected to recycle the liquidity gained to the bank from which it came.⁷⁷ In the simple case of unsecured inter-bank lending, this would simply be re-opening the credit exposure it previously found unacceptable. In the case of repo, it is compounding the problem, and hoarding further liquidity to the extent that the securities used are subject to haircuts.

Any bank that gains from collateral calls and 'haircuts' has an incentive to hoard liquidity. The bank may be driven by precautionary motives or it may wish to preserve this liquidity in order to gain from opportunistic 'cash-in-the market' pricing. After all, the counterparty which has just suffered the call has experienced losses and is now the weaker for them.

In addition to these concerns, the collateralisation of exposures lowers the incentive for a bank to conduct the comprehensive due diligence⁷⁸ of the counterparty's ability to perform at the initiation of contracts. It also lowers the need for ongoing monitoring of the counterparty during the course of the contract. It is evident that bankers, as delegated agents, are subject to moral hazard in this regard, relying on external ratings rather than internally generated information (which is also costly for them to produce). This reduction in the need for the traditional role of credit assessment is also exacerbated by the 'issuer pays' business model of the ratings agencies.

In practice the use of collateral lowers the consequence of a default event while increasing its likelihood and that should be of concern in a systemic setting. It appears that the use of collateral security in the management of derivatives exposures, though sound for any individual bank, carries with it an externality of potentially greater harm for the aggregate system.

72 - It is tempting to attribute this motivation to the observed hoarding by banks of liquidity at the Federal Reserve during the crisis.

73 - The idea of liquidity shortages is not new. In 2003 the Bond Market Association cautioned the European Central Bank that '...the increasing market focus on collateralisation... means that the demands for collateral within the financial markets are rapidly increasing and can be expected to increase very significantly in the future.'

74 - See footnote 11 for ISDA estimates of collateral magnitudes.

75 - There is also an incentive for banks not to hedge derivatives obligations fully in the event of liquidity shortages since these may be viewed as discretionary. In other words, there is an incentive for the bank suffering liquidity stress to assume higher market risk.

76 - In addition to demonstrating that markets may not be reliable for finance-as-you-go strategies, the theoretical examination of guarantees casts light on one aspect of the difference between a derivative and a traditional asset, such as a loan. No bank ordinarily enters a loan agreement expecting a loss but with guarantees, the act of exercise ensures precisely that. Moreover, it illustrates one way in which liquidity shortfalls may arise. Using the figures of the earlier illustration (Box 5), the bank should not expect to be able to finance more than it can assign as security—the pledgeable future income is twelve but it requires twenty under the contingency.

77 - This is particularly true of central counterparties.

78 - As an illustration of this incentive effect in action: ICMA (International Capital Market Association) report that anonymous repo trading within electronic trading systems has risen to 18.3% of that activity, and attributes this to the increased use of central counterparties.

The scale of derivatives activities is highly suggestive of over-trading⁷⁹ activity by the banks;⁸⁰ their emphasis being upon trading or flow liquidity with no recognition that, *ceteris paribus*, this would raise the demand upon the liquidity stock. Moreover, such trading greatly increases the dependencies and possibility of contagion among banks and derivatives traders. The use of collateral to lower the consequences of these dependencies places greater stress on an already insufficient stock of liquidity.

10. Conclusions

The very simple model developed by Holmstrom & Tirole demonstrates that markets have limits and that reliance upon them alone for bank funding is flawed. We have considered trade-offs between transaction, or flow, liquidity and the liquidity stock. Much of market participant activity emphasises the former and ignores the latter. It also demonstrates that derivatives activity, even when fairly priced, can reduce the liquidity stock. The ICMA 2009 survey reports that more than \$4 trillion of collateral was posted in support of derivatives contracts.

Liquidity has not figured on the international regulatory agenda until recently. In Basel II it was evident (though obscured may be more correct) only in that tier-two capital admitted debt securities with a term longer than five years—the term being related to liquidity demand.

We have documented material issues associated with the stock of liquidity for banks engaged in both risk management services and traditional loan and deposit banking. We have illustrated that the scale of these activities may impose significant pressures on both a bank's and the system's liquidity. We have considered the role of collateral in this process. We believe that central counterparties, which are widely advocated in resolution of some of the perceived difficulties with derivatives, will not resolve these liquidity and related problems but rather will concentrate them. We have noted some consequences of derivatives of concern for financial markets—the induced path-dependency—as well as for the economy and for bank shareholders, in particular, weakened management due diligence incentives.

11. Monetary Policy

One way of viewing the situation prior to the crisis was that liquidity was very cheap, a low differential between secured and unsecured market rates, and that the supply curve was therefore close to flat. In this situation banks have an incentive to attempt to create further demand, since that should increase their profitability, and that can result in the follies evident in the sub-prime market as assets were created. It also means that demands upon central bank funds would have been muted. When the crisis took hold central banks lowered their collateral requirements and announced that they would supply secured funds as required by the banking system—this unlimited amount makes the supply curve horizontal at the policy rate and implies a very large demand for central bank funds.⁸¹

If we lower the amount of eligible collateral or limit secured financing activity in the open market, the supply curve steepens as more pressure is placed upon unsecured inter-bank activity. The corollary is that if we increase the amount of eligible collateral then we flatten the supply curve and lessen demand for central bank funds. This suggests very strongly that one good candidate for the clearly needed macro-prudential policy toolbox is collateral eligibility and haircut policy. As this is clearly independent of the policy rate, it satisfies the Tinbergen rule that there should be one tool for each objective. Raising eligibility standards would have the effect of decreasing available

79 - When liquidity is perfect or even just low in cost there are few limits on the ability of banks to create new assets, and many do so—the pro-cyclicality debate is relevant here. The financing limits faced by industrial concerns when over-trading are less onerous for a bank as it is creating further inside money by this over-trading activity. One potential indicator of over-trading, and the potential magnitude of consequence in crisis, would be the ratio of inside to outside money held by the bank. Ultimately, of course, these bank-created assets, and any contracts supported by them, will become information-sensitive (see Dang *et al.* for a recent analysis of this issue) as the bank's capital resources decline in significance, that is as the bank becomes a weaker, more volatile credit. An equivalent overtrading situation with derivatives lies in the possibility of hedging exposures with other counterparties, which allow the bank to commit to contracts it cannot expect to complete from its own resources alone. Collateralisation of exposures provides comfort in this situation, but at the cost of greater systemic harm in extremis.

80 - It also raises questions as to the absolute size of the banking sector, the level of indebtedness in economies and the proportion of income necessary for interest payments and debt amortisation.

81 - A number of European banks responded by packaging their mortgage assets into covered bonds which they then used as collateral at the central bank. A covered bond differs from a conduit or SIV (structured investment vehicle) in that the assets remain on the bank balance sheet and the bond is expressly an obligation of the bank issuer.

collateral and lowering the incentives for banks to try to create new assets. In more general terms, this tool would influence the composition of banks asset portfolios. In macroeconomic terms this influences the shape of the supply curve. Continuing to have large flows of collateral in the banking system associated with derivatives activities would only muddy the water and make the use of this tool more difficult.

The use of such a tool would also go far in resolving the time inconsistency problem of current fixed eligibility and haircut policies identified in Tucker [2009].

12. Financial Guarantee Insurance

It is patently clear that the presence of an insurable interest is a *sine qua non* with respect to contracts which are insurance in nature, if not legal form. It should be equally clear that an insurer writing financial guarantee insurance should not offer security collateral as support for a policy. If an insurer and insured wish to write a policy where the consequence of the insured event exceeds the insurer's potential ability to pay, then either a hypothecated excess of loss reinsurance policy or a policy written as a proportional share, syndicated 'risk' would resolve the problem. This paper is merely an initial step on a path which clearly merits much further research—in large part that research programme is plagued by problems of data—both availability and compilation techniques are wanting. Nonetheless, from this start we can propose several policy recommendations.

13. Recommendations

1. Split the activities functionally into a traditional bank and a financial risk management services company.

Banks may act as securities markets brokers but not as securities underwriters or financial guarantors more generally. Banks may use derivatives for asset and liability management but not become traders in this form of insurance. The financial risk management services company would not be authorised to take unsecured retail or wholesale deposits.

This is apparently similar in spirit to the 'Volcker rule' but in fact differs materially if the intent of that rule is understood as being that banks should use their capital only to serve the interests of their clients, rather than trying to generate speculative profits for their owners. Our recommendation would see underwriting, market-making in derivatives and financial guarantee insurance—that is to say, businesses where they, as principal, have capital market consequences—separated from those which are traditional banking.

2. Alternately if we do not wish to split activities functionally, prohibit the use of collateral security as support among banks for OTC derivatives contracts.

It may seem profoundly odd to prohibit the use of collateral in support of the exposures arising under derivatives contracts when this collateral security lowers the risk profile of the bank receiving it—that is clearly sound risk management for the bank concerned. However, it is important to realise that it does so at a cost to the bank providing it—and that increases the likelihood of that bank failing. The practice of providing collateral in support of derivatives contracts disrupts the liquidity redistribution process of traditional banking, to its detriment.

Moreover, it is precisely the use of collateral that allows banks to grow ever larger in pursuit of increased gross profits. The disparity between gross leverage and risk-based leverage is then stark. With this increase in scale, lower quality assets are created until finally some borrower or class of borrower defaults, and some banks are poorly positioned to weather the cascade that ensues. The steps in the process of decline of asset creation are well known. Banks first lend against expected

cash flows which can service both interest and amortisation payments and proceed until in the final phase loans are made against security, which must itself increase in value in order to pay loan interest and principal. In turn, as the difficulties in those banks become common knowledge general contagion follows and results in complete financial instability. This prohibition would have the effect of lowering the volume of derivatives transactions undertaken by banks and would also concentrate the minds of these bankers on the credit status of their counterparts. It would separate financing from credit support. It would lower the amount of unsecured lending⁸² while increasing the amount of collateral available for secured interbank and central bank discount window funding. The requirement in this situation is for adequate capital to support trading activities, not adequate liquidity. This simple modification to market practice resolves many of the difficulties identified in this paper.

Many commentators have observed that this crisis is a question of trust, which prompts our corollary proposition that if money (liquidity) is merely a symbol of trust, collateral security is a symbol of distrust.

References and Bibliography

Authors' names followed by a date in square brackets are cited references in this paper. Others are useful ancillary reading on the topics raised in the paper.

- Acharya V., Gale D., & Yorulmazer T., 'Rollover risk and Market Freezes', NYU Working Paper 2009
- Acharya V. & Merrouche O., 'Precautionary Hoarding of Liquidity and Inter-Bank Market Freezes: Evidence from the Sub-prime Crisis' NYU Working Paper 2009
- Afonso G., Kovner A., & Schoar A [2010] 'Stressed Not Frozen: The Federal Funds Market in the Financial Crisis' Staff Report no 437, Federal Reserve Bank of New York, March 2010
- Adrian T. & Shin H., 'Liquidity and Leverage', Working Paper Princeton University, May 2008
- —., 'Financial Intermediaries and Monetary Economics' Staff Report no 398, Federal Reserve Bank of New York, Feb 2010
- —., 'Money, Liquidity and Monetary Policy' American Economic Review papers and proceedings 99:2 May 2009
- Aghion P., Bolton P. & Tirole J., 'Exit Options in Corporate Finance: Liquidity versus Incentives' *Review of Finance* 3, 2004
- Akerlof G., 'The Market for Lemons, Qualitative Uncertainty and the Market Mechanism', *Quarterly Journal of Economics* 84 1970
- Allen F. & Carletti E., 'The Role of Liquidity in Financial Crises', Working Paper European University Institute 2008
- Allen F., Carletti E. & Gale D., 'Interbank Market Liquidity and Central Bank Intervention' *Journal of Monetary Economics* 56 (5) July 2009
- Allen F., 'Market Illiquidity and Financial Instability', Working Paper University of Pennsylvania, 2008
- Allen F. & Gale D., 'Financial Contagion', *Journal of Political Economy* 108, 2000
- Anderson R., 'Sense and Nonsense in the Current Debate about Credit Derivatives' Note LSE 2009

- Ashcraft A., McAndrews J. & Skeie D., 'Precautionary Reserves and the Interbank Market', Federal Reserve Bank of New York Staff Report no 370, 2009
- Berger A & Bouwman C., 'Bank Liquidity Creation', Wharton Financial Institutions Center Working Paper
- Berger A. & Bouwman C., 'Financial Crises and Bank Liquidity Creation', Wharton Financial Institutions Center Working Paper, 2008
- Bhattacharya S. & Gale D., 'Preference Shocks, Liquidity and Central bank Policy', Cambridge University Press, NY, 1987
- Biais B., Rochet J-C. & Wooley P., 'Rents, Learning and Risk in the financial sector and other innovative industries.', FMG Discussion Paper 632, 2009
- Bini Smaghi L. [2010], 'Has the Financial Sector Grown Too Big', Speech at Nomura Seminar, Kyoto 15 April 2010.
- Bolton P., Santos T. & Scheinkman J., 'Market Liquidity and Public Liquidity' *American Economic Review* 99, 2009
- Bolton P., Santos T. & Scheinkman J., 'Outside and Inside Liquidity' Working Paper April 2010
Bouye E., 'Portfolio Insurance' FERC Working Paper , Warwick Business School 2009
- Brunnermeier M. & Pedersen L., 'Market Liquidity and Funding Liquidity', *Review of Financial Studies* 22 (6) 2009
- Calice G., Ioannidis C. & Williams J., 'Credit Derivatives and the Default Risk of Large Complex Financial Institutions', University of Southampton Working Paper, April 2010
- Cox J. & Leland H., [2000] 'On Dynamic Investment Strategies' *Journal of Economic Dynamics and Control* 24, 2000
- Dang T., Gorton G. & Holmstrom B., [2010] 'Opacity and the Optimality of Debt for Liquidity Provision.' Working Paper, Yale University 2010
- Demyanyk Y. & Van Hemert O., [2008], 'Understanding the Subprime Mortgage Crisis' Working Paper, Federal Reserve Bank of St Louis 2008.
- Diamond D. & Dybvig P., 'Banks Runs, Deposit Insurance and Liquidity' *Journal of Political Economy* 91, 1983
- Dow J., 'Is Liquidity Self-Fulfilling', *Journal of Business* 77 2004
- Edwards, F. & Mishkin F. [1995] 'The Decline of Traditional Banking: Implications for Financial Stability and Regulatory Policy.', Federal Reserve Economic Policy Review, July 1995
- Elul R. [1995], 'Welfare Effects of Financial Innovation in Incomplete Market Economies with Several Consumption Goods', *Journal of Economic Theory* 1995
- Farhi E. & Tirole J., [2009 - 1] 'Bubbly Liquidity' Working Paper, Harvard University and Toulouse School of Economics, 2009
- Farhi E. & Tirole J., [2009 - 2], 'Collective Moral Hazard, Maturity Mismatch and Systemic Bailouts' Working Paper, Harvard University and Toulouse School of Economics, 2009
- Fegatelli P., [2010] 'The Role of Collateral Requirements in the Crisis: One Tool for Two Objective?' Working Paper, Banque Centrale du Luxembourg 2010
- Freixas X., Martin A. & Skeie D., 'Bank Liquidity, Interbank Markets and Monetary Policy', Staff Report no 371, Federal Reserve Bank of New York, Sep 2009
- Froot K., Scharfstein D. & Stein J., 'Risk Management: Co-ordinating Corporate Investment and Financing Policies', *Journal of Finance* 48. 1993

- Geneva Report, [2010], 'Systemic Risk in Insurance – An analysis of insurance and financial stability' The Geneva Association, March 2010
- Gorton G. & Hiuang L., 'Liquidity, Efficiency and Bank bail-Outs', *American Economic Review* 106, 2004
- Gorton G. & Metrick A., 'Securitized Banking and the Run on the Repo' Yale ICF working paper 2009
- —., [2009], 'Haircuts', NBER working paper no 15273, 2009
- Gorton G. & Penacchi G., 'Financial Intermediaries and Liquidity Creation.' *Journal of Finance* 45 1990
- Greenspan A [2010] 'The Crisis', Brookings Institute, 2010
- Haldane A. [2010], 'The \$100 Billion Question' Speech number 433 Bank of England 2010
- Heider F., Hoereva M. & Holthausen C., 'Liquidity Hoarding and Interbank Market Spreads: The Role of Counterparty Risk' European Banking Centre DP 2009-11s, 2009
- Henderson B. & Pearson N., 'The Dark Side of Financial Innovation' Working Paper George Washington University 2009
- Holmstrom B. & Tirole J [1998] 'Private and Public Supply of Liquidity' *Journal of Political Economy* 1009, 1998
- Holmstrom B. & Tirole J [2009], 'Inside and Outside Liquidity' Book Draft
- Honohan P. & Klingebiel D., 'Controlling Fiscal Costs of Bank Crises', IBRD working paper 2441, 2000
- Instefjord N., 'Risk and Hedging: Do Credit Derivatives Increase Bank Risk?' *Journal of Banking and Finance* 29, 2005
- James C., 'The Losses Realised in Bank Failures', *Journal of Finance* 46, Sep 1991
- Jensen M. [1986] 'Agency Costs of Free Cash Flow, Corporate Finance and Takeovers', *American Economic Review* 76(2) 1986
- Kirabaeva K., 'The Role of Adverse Selection and Liquidity in Financial Crises.', Bank of Canada working paper 2009 (available from kkiribaeva@bankofcanada.ca)
- Kiyoyake N. & Moore J. [1997], 'Credit Cycles', *Journal of Political Economy* 105 1997
- Kurlat P., 'Lemons, Market Shutdowns and Learning', MIT 2009 available from: <http://econ-www.mit.edu/files/4822>
- Laeven L. & Levine R., 'Is There a Diversification Discount in Financial Conglomerates?', *Journal of Financial Economics*, vol. 85(2), 2007
- Lehar A., 'Measuring Systematic Risk: A Risk Management Approach' *Journal of Banking and Finance* 29, 2005
- Lewis D., [1969] 'Convention: A Philosophical Study' OUP ISBN 0 631 23257 5 1969
- Lo A. [2009], 'The Feasibility of Systemic Risk Management', written testimony prepared for the US House of Representatives, October 19 2009
- Morris S. & Shin H. [2010], 'Contagious Adverse Selection', Working Paper, Princeton University 2010
- Morrison, A.D. [2001] 'Credit Derivatives, Disintermediation and Investment Decisions', Working Paper, Said Business School, May 2001

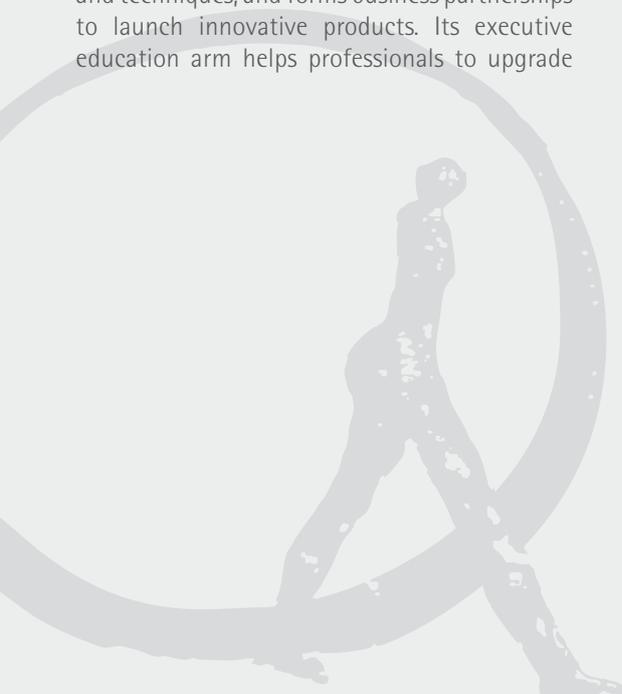
- OECD [2010], 'The Impact of the Financial Crisis on the Insurance Sector and Policy Responses' April 2010
- Pagano M. & Volpin P., 'Securitisation, Disclosures and Liquidity' CEPR Discussion Paper 7105 2008
- Philippon T., 'The Evolution of the US Financial Industry from 1860 to 2007: Theory and Evidence.' Working Paper NYU 2008
- Philippon T. & Reshef A. [2008], 'Skill biased Financial Development: Education, Wages and Occupations in the US Financial Sector, Working Paper NYU, 2008
- Rajan R. [2006], 'Has Financial Development Made the World Riskier?' *European Financial Management* 12, 2006
- Rajan U., Seru A. & Vig V., 'The Failure of Models that Predict Failure: Distance, Incentives and Defaults', Chicago Graduate School of Business Research Paper No. 08-19, 2008
- Schmid, M & Walter I, 'Do Financial Conglomerates Create or Destroy Economic Value?' *Journal of Financial Intermediation*, vol. 18(2), 2006
- Shoham Y. & Leyton-Brown K [2010], 'Multiagent Systems: Algorithmic, Game Theoretic and Logical Foundations', CUP 978 0 521 89943 7 – downloadable from www.masfoundations.org
- Singh M. & Aitken J., [2009], 'Deleveraging after Lehman-Evidence from Reduced Re-Hypothecation', IMF Working Paper WP 09/42, 2009
- Stiroh, K. [2004], 'Diversification in Banking: Is Noninterest Income the answer? *Journal of Money, Credit and Banking*, vol 36(5), October
- Stiroh, K & Rumble A., [2006], 'The Dark Side of Diversification: the Case of US Financial Holding Companies', *Journal of Banking and Finance*, 80, 2006
- Tirole J. [2010], 'Illiquidity and All its Friends', Working Paper Toulouse School of Economics, Feb 2010
- Tucker P., [2009], 'The Repertoire of Official Sector Interventions in the Financial System – last resort lending, market-making, and capital.', remarks at a Bank of Japan Conference - available from Bank of England
- Tufano P., 'Financial Innovation' in the *Handbook of the Economics of Finance*, eds. Constantinides, Harris & Stulz, 2002
- Uhlig H., 'A Model of a Systemic Bank Run' IMF Jacques Polak Conference, November 2009
- Vanhuffel S., Chernih A. & Scoutens W., [2007] 'On the suboptimality of path-dependent pay-offs on Levy markets.' Working Paper, Department of Accountancy, Finance and Insurance, Katholieke Universiteit Leuven, 2007
- Wagner W., 'The Liquidity of Bank Assets and Banking Stability', *Journal of Banking and Finance* 31, 2007
- Wagner W. & Marsh I., 'Credit Risk Transfer and Financial Sector Stability' *Journal of Financial Stability*, 2006
- Woodford M. [1990], 'Public Debt as Private Liquidity' *American Economic Review* 80, 1990

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