Institute and Faculty of Actuaries

Liquidity: essence, risk, institutions, markets and regulation

Sessional meeting

A report of the Liquidity Working Party

17 November 2014

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Abstract

This study is a subjective synthesis of the work of many academics, supervisors and practitioners on the topic of liquidity and many of its multiple aspects. It borrows heavily and freely from those works in the pursuit of coherence, as this subject can be both confused and confusing. Although many hypotheses, both established and speculative, are referred to, none is proposed in this paper.

By liquidity we mean having "access to money". Liquidity of an asset is being able to exchange the asset for money. Liquidity of a market is about being able to sell the assets traded on the market for money. A liquidity flow is how "access to money" moves between institutions or markets as they trade or engage in other forms of economic activity.

In order to be of possible use to a range of readers, it roams from the most basic and elementary to some of the most recent and advanced. In pursuit of brevity and readability, in many instances it can do little more than introduce a particular feature and leave further investigation to the reader. Liquidity is clearly a topic with much unfinished business.

Our ambition in writing this paper is threefold:

- Firstly, to raise awareness amongst actuaries of the wide-ranging implications for actuarial work of liquidity.
- Secondly, to bring some coherence to the manifold measures and uses of the concept of liquidity by attempting to synthesize some of the key elements of knowledge today.
- Finally, to highlight some of the more high profile and open questions relevant for actuarial work.

The paper makes many references to behaviour during the recent financial crisis and its aftermath; however, it is not intended to be a forensic analysis of the crisis attributing causality. The crisis has simply served as an experiment during which many things became observable.

Keywords: liquidity; money; risk; trust;

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1. Introduction

1.1 Perhaps the single most important point in this paper is that liquidity has a cost. If it did not, all assets would be liquid. The cost of liquidity explains the seigniorage collected by central banks from the issuance and distribution of money, and provides a rationale for the transmission channels through which central bank open market operations work. The cost of liquidity should be strictly non-negative[2].

1.2 Much actuarial literature considers it to be illiquidity that commands a premium; unfortunately, while it may be argued this is just a difference in terminology, viewing the world in this way can confuse or mislead. If liquidity comes without cost, we should demand ever more. Private money and credit are far larger than public[3], but there are limits, and this has remained the case even in the post finanical crisis world of inflated central bank balance sheets.

1.3 When considering the *relative* price of assets an 'illiquidity premium' accruing to the investor is equivalent to a liquidity cost. All else equal, liquid assets cost more than illiquid ones. In practice, it is convenient to compare prices to the most liquid, low risk asset (usually Government bonds) as the market price of that asset is readily observable. However, this approach can obscure the mechanism that liquid asset prices are being driven up, in part, by the price of liquidity itself, rather than being a necessary compensation for investing in an illiquid asset. If investors were presented with the additional cost to them of holding their liquid assets, it might well prompt a more thorough consideration of the need for this liquidity. Some holders of liquid securities are operating under regulatory encouragement or compulsion.

1.4 There is substantial empirical evidence that liquidity risk, which arises from changes in specific liquidity and liquidity conditions, is priced in markets (see, for example, Fontaine *et al* 2013). Changes in the price of liquidity will naturally lead to gains or losses depending on what exposure an institution has..

1.5 There is something of a dichotomy in the academic literature on the question of liquidity. Most of the microstructure literature considers liquidity to be beneficial, while much of macroeconomics does not. Keynes' comments (Keynes JM, 1936) are worth quoting: "*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.*"

1.6 In elementary modern finance, such as the capital asset pricing model, liquidity is both free and perfectly available. Models typically assume that investors can borrow or lend freely at the risk-free rate in unlimited quantities, i.e. they face no liquidity constraints. The return on a portfolio then depends on that risk-free rate plus a risk premium; there is no mechanism by which to include liquidity in these simple models.

1.7 The need for liquidity management in practice arises as receipts and payments occur at different times. If liquidity were always available without cost, this would not represent a problem; an institution could simply borrow to make immediate payments. This characteristic would result in unlimited demand from institutions, while no incentive would exist for banks to produce liquidity. James Tobin (1963), the economics Nobel laureate, argued that banks do not possess such a 'widow's cruse', referring to a biblical story in which a widow is able to miraculously refill a cruse (a pot or jar) of oil during a famine.

1.8 The availability of liquidity is systemic; it depends on the willingness and ability of the banking system as a whole to distribute liquidity across financial markets and banks. This can have profound consequences for diversification effects in financial asset portfolios. It is also important in the context of the increasing proportion of GDP relating to finance in our economy, but this aspect is not considered in this paper.

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[1] The cost of liquidity can be zero, a circumstance that has prompted much debate among central bankers about the zero lower bound and the effectiveness of monetary policy.

[2] Around 97% of the money stock is private money – deposits in the banking system.

1.9 At its heart, having sufficient liquidity is about having sufficient access to money to meet any payments due. For an asset, liquidity measures the degree of inter-exchangeability of money and the asset. A liquid asset gives the holder confidence that they could exchange it for money readily were money required. In section 2, we therefore start by providing some context on money itself, before then linking monetary theory to liquidity. We then examine alternative ways of organising exchange that do not rely on money, as well as considering the concepts of trust and confidence that underlie all markets, and which can be most noticeable by their absence. One key point for debate is the extent to which collateralised trades reduce liquidity flows and hence the consequences of the current direction of regulation for financial institutions. By liquidity flow, we mean the way that "access to money" can pass from on institution to another depending on the trades or contracts they agree with each other. An important point to consider is whether the current regulatory drive on liquidity is likely to enhance or reduce liquidity for market participants and outsider users of markets.

1.10 In section 3, we move on to look at liquidity proper. Agents will be concerned with default; cash is king and managing liquidity means providing assurance about having cash in the future. Market liquidity provides investors with the option of selling investments 'early', i.e. liquidating positions and exchanging assets for money. In order to get some level of assurance about future access to money a multiplicity of liquidity models has been devised to consider the liquidity of assets, asset classes and markets. This requires measurement, and in section 3, we highlight the challenge facing us; the sheer number of liquidity proxies highlights the limits of our current understanding.

1.11 Liquidity risk, or the change in the liquidity properties of an asset, also tends to be asymmetric; assets tend to become more liquid only slowly over time, whereas new information can rapidly lead to a very swift destruction of liquidity in a given market or security.

1.12 In section 4, we consider liquidity of markets. We highlight how some terminology can cause confusion, for instance with derivatives where liquidity of the contract does not necessarily lead to material flows of money between creditors and debtors, and hence does not encourage the flow of liquidity around the wider economy. To first order, markets do not create liquidity for economic actors, they simply allow for its redistribution.

1.13 In section 5, we view liquidity from an institutional viewpoint, covering both financial investors and wider corporate treasury functions. We try to raise the bar in common actuarial thinking about how we should aspire to model liquidity in asset portfolios, facilitating better decision making about the relative attractiveness of different assets with both differing yields and liquidities. For some liquidity acts as a risk management mechanism; access to money can be achieved through onward sale of the asset rather than through reaping the income stream produced by the asset itself.

1.14 In section 6, we take a detailed tour of US bond markets in recent years, as a case study of how people assess liquidity in practice.

1.15 In section 7, we consider liquidity regulation and policy; a very active area given the evolution of Basel III and CRD IV. It is also highly topical given the continuing momentum towards mark-to-market regulatory models and the ensuing and undesirable pro-cyclicality this induces (Bank of England, 2014).

1.16 In section 8, we conclude and summarise the major questions actuaries and analysts should be asking themselves about liquidity, when implementing investment and ALM strategies.

1.17 Finally, in section 9, we provide a glossary of some of the acronyms used throughout this paper.

2. Money matters

2.1 Investors value the option of liquidating an asset for money. This might be because they have liabilities that need to be met in cash, to finance discretionary spending, or because they may wish to remove their economic exposure to that asset.

2.2 It is worth drawing an artificial distinction between investor specific reasons for crystallising the asset (e.g. liabilities of that investor) compared to broader market reasons (e.g. secular change in views on the attractiveness of an asset class). The distinction is artificial as no investor acts in a vacuum. However, where the investors' motivation for selling the asset is primarily due to changes in market views, liquidity can disappear when it is most desired.

2.3 However, in this chapter, we focus on money itself. We start in 2.1 with a definition of money in the modern world, before moving on to consider monetary theory in 2.2, alternatives to money in 2.3 and then trust and confidence in 2.4 ending with guarantees in 2.5. Trust, confidence and guarantees are essential to the function of money in society as well as to markets. A key challenge emerging from this chapter for the current direction of regulation is the extent to which collateralisation actually reduces liquidity transfer through the financial system. Given the potential for a scarcity of collateral (Singh, M, 2013), and the impact on these reduced liquidity flows, this is potentially a major issue. Although, (Hauser, A, 2014) claims that that idea of a collateral crunch is no more than a myth.

2.1 Money

2.4 Money is a type of IOU, but one that has been given special status (for example as legal tender) so is trusted by everyone in an economy. There are three main types of money: currency, bank deposits and central bank reserves. Money is special because in most circumstances everyone in the economy trusts that it will be accepted as a form of payment (McLeay et al, 2014).

2.5 Classically, we view a loan from a bank as creating the corresponding bank deposit; a purely inside and balanced activity. When inside money is created by banks in this way, it is extinguished by the discharge of the loan. There is no need for any pre-existing savings deposit for the bank to create this money. Indeed, if many savers choose to hold deposits, that is, to hoard liquidity, rather than make investments or consume, there would be a sub-optimal level of investment and concomitant lack of consumption demand[7]. This is a real economic cost.

2.6 Richard Werner (2014) gave an insightful critique of the standard economic view of money creation and interest rates as a price of money. In particular, he expounded that in rationed markets (where supply or demand are limited), the short side (i.e. the supply side if supply is lower than demand, or the demand side if demand is lower than supply) had power to impose non-market costs on the long side; simply, there was no theoretical reason or empirical evidence that the market would clear any other way. Given that we might reasonably postulate that the demand for money is infinite, this makes the supply side the side with power. As banks dominate the money supply through credit creation, the banks have the power and the corresponding responsibility of managing this public good.

2.7 Money is to an extent self-referential. Money is what people accept as money (King M, 2006). Abstractly, it is a symbol of trust. Although the need for money will arise from distrust – we use money precisely because we will not accept private debts as money. "Distrust is the root of all money" (Kiyotake, N and Moore, J, 2001). In rather crude terms, we accept money because we trust that it will be accepted by others in future.

[7] It is the wages of workers employed in the production of investment goods that constitute the profits of producers of consumption goods.

2.8 There are assets that we would not ordinarily consider as money which are liquid. However, liquidity is less a fundamental attribute of an asset and more a diagnostic of the state of the market in that asset; we can sell an asset only if there is a corresponding buyer. The price of any asset is driven by the supply and demand for it, and that is driven in turn by the attributes of the asset, as well as other factors such as the state of the economy, attitudes to risk, taxes and other government policies.

2.9 The standard taxonomy of money is that it serves as a unit of account, means of payment, medium of exchange and store of value. As a unit of account it is merely a record and need have no physical form. Its role as a means of payment is obvious in the legal tender context mentioned earlier. As a medium of exchange, it becomes more interesting as, by the simple process of deferring payment for an exchange, we may create money. As a store of value, it offers certainty in nominal terms, which no other financial instrument does. In result, flights to cash are well known in times of high uncertainty.

2.10 These roles may interfere with one another. While it is obvious that we may always save and use money as a store of value, this restricts the use of this money in other roles, such as means of payment. Banking may be seen as a method of alleviating this interference issue.

2.11 The desirable properties of money, rather than the functions with which we are principally concerned, were enumerated by WS Jevons, (1875):

1 Utility and value
2 Portability
3 Indestructibility
4 Homogeneity
5 Divisibility
6 Stability of value
7 Cognizability

This latter term, cognizability, refers to the ease of recognition or verification of an instrument[9]. Many of the design features of securities that enhance their liquidity can be seen as attempts to reproduce some aspect of these seven properties. The degree to which technological progress has altered the relative importance of these properties would be an interesting study for a historian.

2.12 The legal tender status of money assures payment finality in transaction completion. The difference between money in its role as a means of payment and as a medium of exchange is one of timing – in payment the exchange of money and good are usually simultaneous, but as a medium of exchange, they may be separated in time, and arranged through the acceptance of a financial instrument. When exchange is separated in time, the participants in the trade will be concerned with the creditworthiness of each other, an underwriting process that is a recurring theme through our considerations of liquidity. The confidence with which we believe others will make payments to us is intrinsically linked to how much liquidity we expect them to have in future. People will grant credit if they expect future liquidity.

2.13 For institutional liquidity, it is primarily the exchange of money and securities in electronic rather than physical form that is relevant; this motivates, in part, the consideration of the payments and settlements systems in section 4.2.

2.14 Money is the medium through which markets mainly operate. However, it is not uncommon for assets to be exchanged for other assets rather than their cash equivalent – in, for example, bulk annuitisation. This is transfer in specie. We will briefly discuss barter in section 2.3. Assets can also serve as collateral, though

[3] This characteristic is also the forger's friend. With ease of recognition we do not spend much effort in verification of a banknote.

usually not at face value. The discount ("the haircut") applied to collateral in, for example, repo transactions, is usually considered as a risk management device, but it has antecedents in the concept of Divisia money.

2.15 "Haircuts" also serve, in a manner similar to the deductible of an insurance policy, as a mitigant of moral hazard; they increase the likelihood of performance (that is repayment) by the borrower of funds under the repo contract.

2.16 The Bank of England produces a Divisia index for money, which weights the growth rate of each of the M4 component assets according to the extent to which they are estimated to provide transaction services. These weights are a function of the interest rate on the asset, such that assets with a higher interest rate are assumed to provide fewer transaction services. This weighting method is clearly an approximation to the truth.

2.17 The US Federal Reserve used to publish a broad money index– the L series, which included some US Treasury securities. The US Centre for Financial Stability[11] makes the following observation: " *Extensive published results demonstrate that the best monetary aggregate for almost all uses was the Federal Reserve's former broadest aggregate, L, but only if computed as a properly weighted index number, such as the Divisia or Fisher-ideal index.*"[12]

2.18 It is clear that the recent financial crisis was much exacerbated by the decline in prices of many securities that were widely used as collateral in repo and other transactions. The widening of 'haircuts' between 2007 and 2009 has been widely documented. Many securities, such as AA and lower rated MBS and structured products, became entirely ineligible as collateral security, even for the best counterparty credits. This contraction in broad money was very substantial and should have been expected to have the contractionary economic effects that came to pass.

2.19 In this light, the Bernanke statement in the summer of 2007 to the effect that the stock of sub-prime mortgages was insufficient to cause systemic banking issues was correct. He observed, accurately, that there were only $750 billion of these mortgages in existence, far less than the banking system's capital resources, and they were indeed not very important in terms of monetary aggregates. (Equity in the banking system is a substitute for liquidity, which lowers the likelihood of confidence-based runs and permits lower liquidity buffer holdings.)

2.20 However, this omitted consideration of the $4 trillion nominal of inside mortgage derivatives written mainly on the ABX-HE indices. When the prices of these index contracts and synthetic securities based upon them plummeted, they resulted in inside flows (that is flows among the banks, hedge funds and others) of the order of $1.5 trillion, under mark-to-market credit support agreements and other covenants. These ABX indices are synthetic[13] and, like all such products, magnify the consequence of an event in the referenced assets (Keating, C and Marshall, B 2010a); to the extent that contracts are written on these indices, the losses experienced for individual holders of the derivatives are larger than the actual losses on real mortgages[14]. The derivative exposure across all institutions will be, by definition, zero – however, the turmoil caused by the very sizeable flows was substantial.

2.21 This had pronounced effects in the distribution of liquidity within many financial system institutions, and resulted in collapsing market prices, as liquidity-constrained owners sought new and replacement liquidity to finance assets that now had far lower collateral value. One of the notable channels for these liquidity calls

[4] http://www.centerforfinancialstability.org/amfm.php
[5] See http://www.jstor.org/stable/1928524 for a description and comparison of Fisher Ideal indices.
[6] This simply means that they do not rely upon the underlying for settlement, though they reference the price of the underlying.
[7] They were also prominent instruments in the construction of synthetic CDOs, which accounted for 15-20% of issuance in that market.

and pressures was under the lines of credit written by sponsors and other banks in support of earlier mortgage securitisations. We shall return to this later towards the end of section 2.3.

2.2 Monetary theory and liquidity

2.22 Since at least Clower, R (1965), modern monetary theory has revolved around three propositions:

1 Money may buy goods and goods may buy money, but goods cannot buy goods.
2 Money is always a debt.
3 Default on debt is possible[18].

2.23 It should be realised that money is not a good that can be produced by labour. Furthermore, money does not directly satisfy the needs and desires that motivate the production of goods. In more popular parlance: you can't eat money.

2.24 Money as debt led Hyman Minsky to say that anyone can create money, but the problem is to get it accepted. There is no intrinsic economic barrier to private monies, no absolute requirement that it should be a state monopoly. Indeed, through much of history, public and private monies circulated alongside one another[19]. Digital currencies, such as Bitcoin, are a current illustration as are "local" currencies such as the Brixton pound. As Charles Goodhart has argued, one of the reasons that general equilibrium economic models find no role for money is that their single representative agent has that agent as both creditor and debtor; a situation in which it would be profoundly irrational for default to occur. Richard Werner (2014) succinctly argued that actually looking at a general equilibrium model is the wrong place to start for any empirical insight given that no markets are ever likely to be in equilibrium.

2.25 Default is the failure to redeem a debt when validly presented for payment. In many simple economic models, all participants can borrow at the risk-free rate and there is never a liquidity constraint. In this case default would never occur. Another corollary is that financial institutions such as banks, which perform credit assessment, intermediation and monitoring roles, are redundant.

2.26 Recent academic and regulatory work has focussed on increasing the realism of economic models, so that the role of banks and their associated networks are incorporated with liquidity being explicitly present and considered. We introduce some ideas of this nature in section 5.3.

2.27 The legal tender status of a (sovereign) currency is not in itself sufficient to establish demand for that currency; demand for a currency arises from the sovereign ability to levy and collect taxes, fees and fines payable in that currency. The other and more voluminous uses are incidental to this.

2.28 A sovereign debtor is unique in that it may discharge its debts by the further issuance of money, which is merely an extension of its own indebtedness. An individual or institution cannot in general discharge its own liabilities by the issuance of further liabilities; forbearance, or the acceptance of further debt in discharge of a maturing debt, requires the debtor to exhibit continuing good faith and usually the prospect of improved circumstances. For all other than the sovereign, it is usually necessary to exchange their obligations

[18] Default on fiat money is perhaps a difficult concept, since it need only be exchanged for more of the same. However, suppose that a sovereign fiat money was replaced by a new currency at an exchange rate of two new to one old, but other obligations, such as government debts, were not subject to revision, then this would de facto constitute a default. In essence, this was what was being done with debasement of the coinage in times past.

[19] "*Competition in Currency, The Potential for Private Money"* Thomas L. Hogan, Cato Institute, May 23, 2012

for this state money, and this is where liquidity enters into consideration; the inter-exchangeability of different assets for state money.

2.29 Several commentators have noted that monthly rollover of payday loans is now commonplace for some individuals. This is simply an instance of forbearance, and has clear limits financially (as with high interest rates the loans will grow rapidly) and politically (if secure and responsible lending is a social objective then ongoing debts at very high APRs is not a good solution). Ultimately, the discharge of these debts, as with all others, will require liquidity, though this may be greatly reduced in an insolvency or bankruptcy process. The common elements to insolvency or bankruptcy processes are that liquidity demands are stayed and schemes of rearrangement or liquidation imposed, which often result in creditors receiving far less than was previously contractually due.

2.30 This need to pay in state money leads to risk management practices such as the holding of high stocks of central bank reserves by banks, relative to their levels of loan creation, as cushions against the uncertainties of this exchange or conversion. This is liquidity hoarding and in excess can limit economic growth and activity. Both access to central bank reserves and deposit insurance serve as mitigants of this exchangeability uncertainty; in result, inside bank money is more widely accepted and used by the public than might otherwise be the case.

2.3 From barter to Bitcoin

2.31 It is notable that from most elementary economics textbook expositions, it would be reasonable to assume that barter markets existed before markets utilising a monetary medium of exchange. However, there is no evidence that this was in fact the case, anywhere.

2.32 The traditional barter exposition of money purports that the production of goods arises before exchange enters the picture; money merely resolves the problems of uncertainty associated with the exchange of those finished goods. It fails to acknowledge that some working capital (money) is needed for the production process. The order of events is over simplified; most production requires financing before it takes place.

2.33 As we shall see in section 4.3, there are analogies between barter markets and investor-only order driven securities markets. Many electronic crossing networks use investor order-matching algorithms.

2.34 It is possible to organise markets for trade and investment under systems that are not liquidity-based. Some, such as Amato, M and Fantacci, L (2012) have argued, loosely following Minsky, that liquidity is the bedrock of our current system of capitalism. This was the heart of Keynes' original proposal of Bancor and an international clearing union, which was recently revived by Governor Zhou (2009) of the Peoples Bank of China. It is also evidenced by the long-standing Swiss co-operative WIR (Z/Yen, 2012), which manages and issues a private currency, the WIR franc.

2.35 Readers interested in financial systems which eliminate money would do well to read Silvio Gesell's 1904 "Die Naturliche Wirtfschaft Ordnung" (The Natural Economic Order) and then consider local exchange trading systems (LET) which in fact exist quite widely in Canada, Australia and New Zealand, and are perhaps best known as the Danish and Swedish J.A.K. systems. This latter system operates through the Swedish Postal Service. Internationally barter or countertrade (countertrade means exchanging goods or services which are paid for, in whole or part, with other goods or services, rather than with money) is estimated to be between 20% and 25% of all trade conducted (Okaroafo, S, 1989).

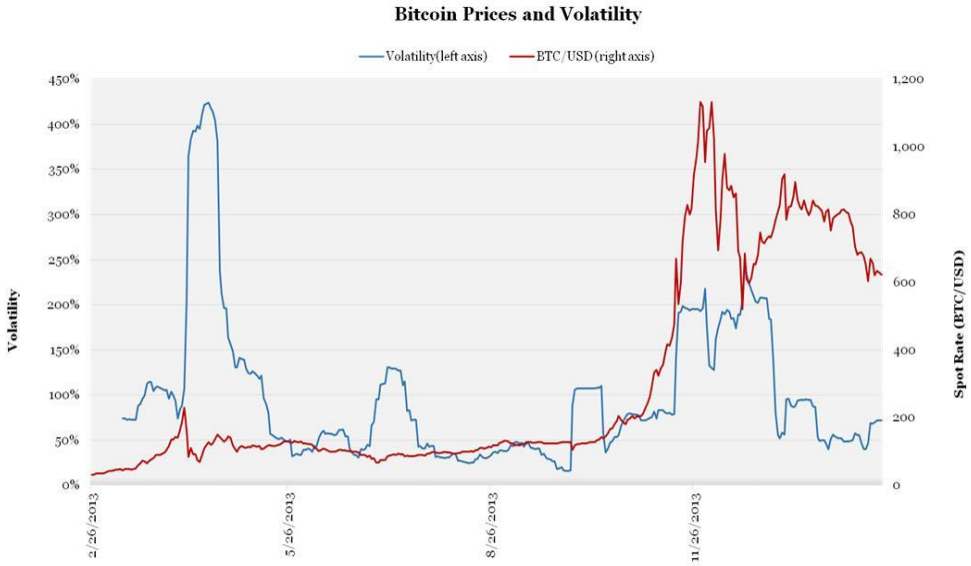
2.36 The problems of the requirement for a double coincidence of wants in barter trade extend beyond merely finding some counterparty. For example, once you have found someone to trade with there is the question of the quantity each of you desire of each other's goods and some goods are not divisible. Technology, such as the internet, can reduce the costs of finding a counterparty. Untraded goods, such as haircuts, would be problematic, as is finding a method of paying employees. The tales of East Europeans being paid in tins of pickled fish or vegetables were not entirely apocryphal.

2.37 It is notable that barter and countertrade, where formalised, were, from time to time, outlawed, such as during the 1930s depression in Germany and Denmark. Trust is as central an element to barter as it is in conventional monetary transactions.

2.38 The spread of technology and the internet has seen the introduction of several virtual monies. Some, such as Mondex, have slipped from public memory. Currently Bitcoin is the centre of much debate and controversy.

2.39 Milton Friedman foresaw such developments in 1999: "*I think that the internet is going to be one of the major forces for reducing the role of government. The one thing that's missing, but that will soon be developed, is a reliable e-cash, a method whereby on the Internet you can transfer funds from A to B without A knowing B or B knowing A. The way I can take a $20 bill hand it over to you and then there's no record of where it came from.*"

Figure 2.1: Price and Volatility of Bitcoin.



Sources: *BitcoinCharts.com, and calculations by Prof. Steve H. Hanke, The Johns Hopkins University.*

Note: *This chart contains the 14 day realized volatility of the price of bitcoin on the Bitstamp exchange. Realized volatility is calculated as the annualized standard deviation of continuously compounded daily returns.*
As of February 20th the price of bitcoin, as indicated on the chart, is 578 per USD with a realized volatility of 75.7%.

2.40 He also foresaw the potential for criminality: "*You may get that without knowing who I am. That kind of thing will develop on the Internet and that will make it even easier for people using the Internet. Of course, it has its negative side. It means the gangsters, the people who are engaged in illegal transactions, will also have an easier way to carry on their business."*

2.41 With Bitcoin now the focus of attention, it is worth considering how well it satisfies Jevons' earlier properties set out in 2.11. Figure 2.1 above shows the US dollar price as quoted on BitStamp and its associated 14 day average volatility. Clearly, the volatility of this Bitcoin crypto-currency has been significant relative to traditional currencies against the US dollar and price homogeneity is atypically low. Indeed, the Economist has reported disparities in price between differing Bitcoin exchanges that have been as much as 50%.

2.42 FTAlphaville (2013, 2014) has a series of fascinating articles on Bitcoins, covering their use as a store of value, seigniorage, and whether they are a way to break through the zero lower bound for interest rates. Among other things, bitcoins offer an interesting empirical experiment into monetary theory.

2.4 Trust and confidence

2.43 Trust and confidence are central elements to well-functioning markets. As noted earlier; money is a symbol of trust. We also need to have trust in the represented quality of the goods or assets offered in markets. Standards have a role here both as benchmarks and as devices to minimise enforcement costs.

2.44 We should distinguish between trust and confidence, though both concepts refer to expectations that may lapse into disappointments. We trust that markets will *function* as we expect but we have confidence in the *ability* of our doctor to cure our ills. The latter question of ability is a competence characteristic, while in the former the concerned is with motivation or predisposition[20]. We can have confidence in the ability of the ATM to deliver cash, but it does not have any functional flexibility, a characteristic of relations of trust.

2.45 A number of authors have diagnosed the financial crisis as a question of trust and proposed remedies accordingly[21]; by contrast, we might see this as the breakdown of the convention that in financial markets, we accept much uncertainty and risk in pursuit of the gains from trade. This convention is sometimes known as 'market confidence'.

2.46 We wish to further distinguish between convention and trust – a convention exists because it provides mutual benefit while trust is unnecessary unless there is a risk of loss, requiring commitment. Driving on the left is one illustration of a convention; it benefits all drivers. Conventions, which often involve simplification, are an enabler for price comparison and serve to reduce perceived information asymmetry.

2.47 In the early 1970s, with vivid imagery of 'lemons'[22] in used car sales lots, George Akerlof gave us important insights into the effects of adverse selection and uncertainty in markets[23]. As we do not know the quality of the car as well as the selling owner, we are exposed to the possibility of exploitation, and reflect this in the price we offer to pay. As the potential information asymmetry mounts, distrust prevails and trade declines - then prices reflect only 'lemons'.

2.48 This is a variant on Gresham's law, that the bad drives out the good. In the absence of convention, this unfortunate situation, which is a question of trust, will prevail and markets cease to function.

2.49 When discussing market valuation in the General Theory, Keynes (1936) observed: "In practice we have tacitly agreed, as a rule, to fall back on what is, in truth, a *convention....* Nevertheless the ... conventional

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[20] There is an interesting and relevant illustration due to Luhman: *As a participant in the economy, you necessarily must have confidence in money. Otherwise, you would not accept it as part of everyday life without deciding whether or not to accept it. In this sense, money has always been said to be based on 'social contract'. But you also need trust to keep and not spend your money, or to invest it in one way and not in others.*

[21] The remedies tend to focus upon the central role of experience in the restoration of trust and the more technical have used models of repeated games.

[22] 'Lemons' are cars of poor quality.

[23] Democritus took the idea of asymmetric information in markets to the extreme by describing them as 'places where men meet to deceive.'

method ... will be compatible with a considerable measure of continuity and stability in our affairs, *so long as we can rely on the maintenance of the convention." [Italics from the original]*

2.50 The financial crisis has reminded us of this convention for market confidence. We recall Chuck Prince's infamous words on this subject "*When the music stops, in terms of liquidity, things will be complicated. But as long as the music is playing, you've got to get up and dance. We're still dancing."* In more normal times, this statement would not have earned him such evident opprobrium. This is also why, before the onset of the 2008 crisis, many risk managers' cautions were disregarded and ignored, like Cassandra; these cautions were a challenge to the pursuit of profit.

2.51 The central insights for the analysis of convention and its problems of co-ordination had been studied before Akerlof's 'lemons'; David Lewis (1969) is the seminal work and Robert Aumann (1976) gave a rigorous mathematical underpinning to the topic.

2.52 Key to the idea of convention is the concept of common knowledge, where the members of a group have similar knowledge and understanding, and also know that all others possess this knowledge. This is related to Keynes' beauty contest analogy for markets, where to win the competition it is necessary to predict the face most attractive to others, rather than the face most attractive to ourselves. Returning to Bitcoin, as an electronic good the value is solely determined by the demand of others; although the same could be said of most goods, with Bitcoin it is harder to identify a fundamental value or income stream that could be derived other than through selling.

2.53 Technology, by making price comparison easy, substantially reduces search costs. Moreover, by propagating common knowledge and enabling trust in the seller through more information disclosure, it may also enhance liquidity in some markets (e.g. buying used cars on eBay).

2.54 Transparency and disclosure are not necessarily unconditionally positive, though they are often presented and promoted as such. It is usually argued that they provide a level playing field among market participants. If the advantage of an institutional investor relative to a retail investor came from the collection of data, then disclosure could level the playing field. But, if as seems more likely, the relative advantage of the institutional investor came from their analysis, processing the data, then disclosure will exacerbate the inequality of the playing field. We return to this in more detail in section 7.5

2.55 The iterated self-referential nature of the concept of common knowledge makes it complicated and best explained by simple example. The time-honoured illustration is of an island inhabited by people who have either blue or green eyes. There are no mirrors on this island, so no-one can know the colour of their own eyes, but they can observe the colour of all other eyes. The etiquette is that people who know they have blue eyes should leave the island immediately and that discussion of eye colour among the inhabitants is taboo. No one will leave the island in this situation.

2.56 Now, a truth-telling visitor arrives who informs the island population that there is at least one blue-eyed islander present. All of the green-eyed islanders can already see all of the blue-eyed present and those that are blue-eyed can also see the other blue-eyed islanders present. So the information gained is slight, but the effect is substantial. If there is just one islander with blue eyes, he now knows immediately that he must have blue eyes since all other islanders are visibly green-eyed, and immediately leaves[24]. If there are many (say, M) blue-eyed islanders present then they will leave together on the same day, after that many (M) days

[24] This is reminiscent of the gambler's adage 'if you can't see the fool at the table, it must be you'.

have elapsed[25]. The visitor is merely a catalyst, who induces the subsequent and later movement of islanders by introducing a modicum of common knowledge.

2.57 This should resonate with market practitioners; explanations for market movements and liquidity events can often feel like decidedly old news? One explanations is that the market movement only occurred after the news had become common knowledge, and was widely understood; alternatively it is justification of a move using readily available arguments, all with the power of 20:20 hindsight. We revisit this topic in section 3.5 when considering the breakdown of the floating rate note market in the mid-1980s.

2.58 The deteriorating condition of the sub-prime mortgage market was widely known long before the rout set in; researchers from the Federal Reserve of St Louis (Demyanyk, Y and Van Hemert, O, 2008) have found that the quality of loans deteriorated for six consecutive years before the financial crisis and that securitizers were to some extent aware of it.

2.59 By the end of March 2007, the ABX (2006 – 2) BBB indices were trading (or not) at prices between 70% and 80% of notional value, and the slide down from there was precipitous. Academic studies (Fender, I and Scheicher, M, 2009) of the pricing behaviour have concluded that the price declines suffered far exceeded those warranted by fundamental default experience. From being positively self-reinforcing market values became negatively self-destroying – one of the channels for spreading this reduction in market value was mark to market asset valuation leading to forced sales with consequent pro-cyclical effects..

2.60 By summer 2007 continued denial of the problems and uncertainty was no longer viable for market participants, and market breakdown ultimately ensued. By year-end UBS, Citibank and Morgan Stanley had all cited the ABX indices when reporting their write-downs of mortgage assets. To the extent that these indices were reflecting more than default experience, this was a channel for contagion[27]and exaggerated loss marking, which lowered the banks' perceived risk bearing capacity. Contagion effects are an economic externality which impairs the public good value of liquidity; in earlier parlance, an economic externality was often referred to as a public nuisance.

2.61 These indices are contractible - derivatives may be based upon them and cash settled[28]. Like all indices, they greatly facilitate the writing of OTC derivatives as they lower the 'lemons' problems of adverse selection and asymmetric information associated with specific tranches of specific mortgage securities that would usually reduce or eliminate trade. These derivatives were, by design, efficient devices for both hedging and speculative purposes, despite with the benefit of hindsight us knowing beyond doubt that the real underlying assets were subject to the 'lemons' problem.

2.62 There is evidence these index-based contracts were used extensively; in the case of Goldman Sachs, mortgage short positions reached 53% of the firm's total value at risk (Memorandum to Members of the Permanent Subcommittee on Investigations, 2010). Fender, I and Scheicher, M (2008) noted that 'with markets reportedly overwhelmed by large speculative short positions, market liquidity...has been impaired...'

[25] This follows as every blue-eyed islander can see M-1 blue-eyed islanders and if no-one leaves on day M-1 and none should, she must conclude that she also has blue eyes – all do this on day M and leave together.

[27] Arbitrage activity where traders sell other unrelated assets in order to buy the underpriced mortgage securities will provide a cross-market channel for contagion.

[28] As these indices are trade-able, they can and did develop a life of their own – unlike, say, an equity index their price did not reflect the arbitrage value of underlying reference assets. In other words, they can be regarded as reflecting not just mortgage credit risk but rather mortgage credit and market risk.

2.63 Market confidence requires a common belief in the fundamental soundness of counterparties by market participants. This motivates research and information discovery in fundamental credit analysis, and indeed provides a specific role for banks. Trust though is not necessarily the issue here.

2.64 Trust is redundant in the absence of a risk of loss. There may be nothing that we can do to "rebuild trust", but there is much that we can do to enhance our own trustworthiness. The aspects of trustworthiness most relevant in the financial services sector are (O'Neill, O, 2012):

- competence;
- reliability; and
- honesty.

2.65 The challenge is to prove our trustworthiness. Most of us can certainly improve our competence and reliability. We can also practise, demonstrate and signal all of these aspects, which should increase the willingness of others to place their trust in us.

2.66 Disclosure can reduce a lack of trust, as can stating exogenous motivations. "Selling the car because I am moving to the West Coast" is an example. Analysis of web-based markets suggests that all else being equal providing more information about your car tends to increases the price, even if that discloses negative information such as bumps or scratches. Perceived uncertainty is reduced and trust is encouraged.

2.67 Reputation is important in the context of the trustworthiness of an institution; it encompasses all of the aspects listed above. Succeeding despite a poor reputation may be possible when you have market power. However, we also saw actions in defence of reputation during the financial crisis which in hindsight were probably misguided (the repurchase of securitised loans).

2.68 Some of these actions were undoubtedly intended to signal financial strength. In general signalling, which must be costly to be effective, may be wastefully expensive. In the case of the ABCP conduits (i.e. the program of issuing short term liabilities in the from of commercial paper to fund long term assets), the damage was already done to a large extent; these were interventions after the withdrawal of short-term funding – the run had already happened.

2.69 In markets, norms and conventions are typically introduced, which also serve the purpose of reducing costs. With norms and conventions, all parties benefit. These are coordination enhancing measures. Standardisation of quality and quantity for a good or commodity is perhaps the classic introduction of a convention. The emergence of formalised commodity exchanges in the nineteenth owe much to their ancillary role in verifying the quantity and quality of the commodity traded. Prior to this costly verification was necessary at all points of delivery of the exchanged goods. Settlement could prove extremely problematic, even for the seller, as the buyer has incentives to reject adequate deliveries satisfying minimum standards. Independent verification was valuable to all.

2.4 Guarantees

2.70 Guarantees are substitutes for trust; they will not enhance it, though they may increase exchange activity. Reducing the hazard or consequence does not improve the degree of commitment or trust; rather it reduces it. Centralising counterparties in markets is an example which increases confidence and enhances coordination by eliminating the need to verify the credit standing of a buyer.

2.71 Collateral, which lowers (credit risk) exposures, is another trust substitute. There are several problems with collateral security supporting a transaction. As collateral is a form of liquidity, collateralised transactions have lower effective net liquidity flows and higher costs. Collateral arrangements are substitutes for trust-based agreements and cooperation, and can be expected to crowd them out. They serve to increase

our confidence rather than our trust; market liquidity based upon confidence-enhancing measures usually involves an increase in gross liquidity, with a simultaneous decrease in net liquidity flows.

2.72 The security grantor / supplier of collateral has a lower stock of unencumbered liquid assets; this is sometimes referred to as 'hollowing out'. The position of a senior unsecured creditor can be undermined by the excessive use of collateralised financing, unfortunately in a manner which is not immediately transparent.

3. Liquidity risk

3.1 The liquidity of an instrument may be considered as a real option for the holder of the instrument to negotiate or sell it at a market price. This provides "access to money" and in common with other options, this typically has a cost to the holder of the option. A non-negotiable, but otherwise similar, instrument will cost the holder of the instrument less and have a higher current yield. The value of the liquidity option will be different for different investors and for each investor may vary over time.

3.2 As with any other scarce resource there is value in managing liquidity, including understanding how it might change and seeking to mitigate our exposure based on our requirements and appetite for liquidity risk. We go further, and ask whether the current scale of the desire for liquidity is even attractive, compared to the benefits of encouraging long term investment (Kay J, 2012). With deliberately provocative language, we might say that liquidity affords investors the luxury of a lack of commitment to their investments. We also note the risk asymmetry with liquidity, which leads to a large downside risk for those (often subconsciously) relying on liquidity in particular markets.

3.3 In this chapter, we start in 3.1 by looking at liquidity management, before moving on to the wide range of market measures of liquidity in 3.2, noting that some measures of liquidity which focus on flows inside markets overstate real liquidity flows in the broader economy. It is these latter flows that lead to wider economic benefits. We then consider financial depth in 3.3 and liquidity risk in 3.4 and change in 3.5. We conclude in 3.6 by revisiting the statement from Keynes in paragraph 1.5 about the lack of liquidity for investors as a whole.

3.1 Liquidity management

3.4 As liquidity has a cost means we should be parsimonious with it. This is not motivated by some Victorian notion of thrift as a virtue, but because of the cost to the economy in sub-optimal output if we are spendthrift with liquidity. There is also a precautionary rationale for parsimony, since the private sector may not produce sufficient liquidity to support optimal economic output. Liquidity regulation and its associated demands for stocks of liquidity, to which we shall return in section 7, is an importance influence on the accessibility of liquidity within the economy and so this regulation should be implemented thoughtfully.

3.5 Appropriate management of liquidity at the level of institutions is not the same as the management of liquidity at the level of the economy. Optimal management of institutional liquidity may result in sub-optimal liquidity at the level of the economy; these economic externalities can justify regulation of liquidity.

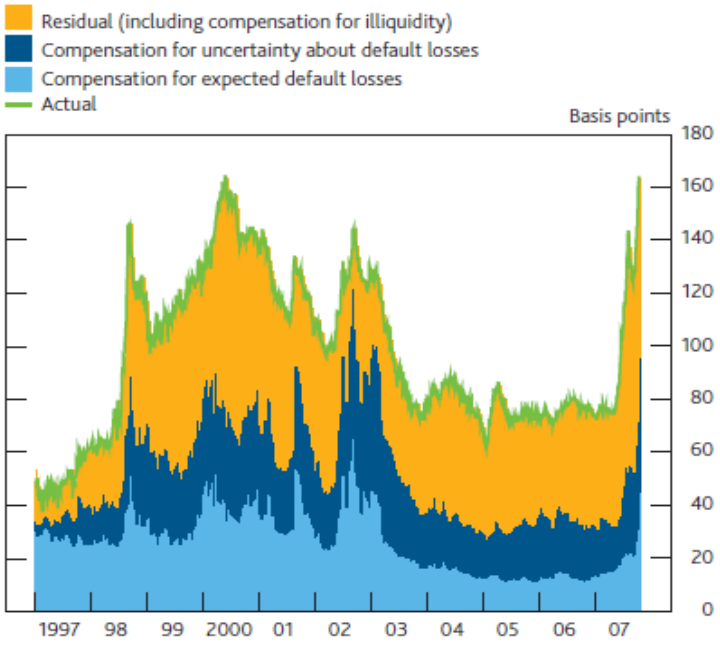
3.6 In order to manage, it is necessary to measure and there is a challenge in that liquidity is not explicitly priced. In a world without uncertainty and change the cost of liquidity would be fixed. In financial markets, where uncertainty and change are dominant characteristics, it is not possible to observe the price of liquidity directly. The consequence is that, to a greater or lesser extent, all measures of liquidity rely on some arbitrary separation of liquidity and value effects.

3.7 A couple of points arise here: first, the nebulous nature and use of the term liquidity means that it can easily be blamed for all manner of financial problems. Second, and more importantly, this makes riskless arbitrage or hedging activity all but impossible; almost any hedging strategy will introduce secondary liquidity concerns. Standard option pricing theory in complete markets requires self-financing portfolios, which explicitly assume liquid trading of the underlying elements. For example, a corporate bond hedged with a credit default swap (CDS) is exposed to the possibility of margin calls on the CDS.

3.8 However, decomposition of credit spreads using a Merton model has become standard practice, as is shown below (Figure 3.1) for investment grade sterling corporate bonds.

Figure 3.1: Decomposition of Credit Spreads (Bank of England)

Chart 1 Decomposition of sterling-denominated investment-grade corporate bond spreads



3.9 While this decomposition has a number of limitations, it does serve to illustrate that changes in the residual term (which among other things include the cost of liquidity), may from time to time be the dominant factor driving the credit spreads available in markets. Changes in this residual term then provide one reason for the fact that market price charged for accepting credit risk appears far more volatile than might be expected from a forward looking view of insolvency likelihoods.

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3.10 If you purchase liquid securities, and hold them for the long term, you do not benefit from their security. It is notable that the buyer of liquid 'on-the-run' securities can expect in a long-term buy and hold strategy to lose some or all of the price premium that these securities initially commanded when trading as benchmark securities. This is akin to buying insurance (a liquidity option) for a risk (lack of liquidity) which you plan not to expose yourself to (since you do not intend to sell the security so do not need the liquidity).

3.11 As noted above, the market price of liquidity varies over time. The prices of assets are measured in money, but money itself has a price. This means that you can trade (albeit indirectly) in changes in the price of liquidity.

3.12 The cost of market liquidity is not a pure dead weight. It affords investors to use the liquidity of the securities they purchase as a risk management mechanism. However, such investors will not feel compelled to invest for the long term – these are speculators to the extent that they seek gains from changes in market price and not necessarily from changes in the obligor's fundamental circumstances. By contrast, fundamental investors will tend to be active in and hold illiquid instruments, where they expect their research and analysis to be better rewarded (Kay, 2012).

3.2 Market liquidity measures

3.13 In a simple market context, liquidity is the degree of negotiability, which means that there are several possible dimensions to, and consequently measures of market liquidity. The most widely cited are due to the late Sir Andrew Crockett, a past General Manager of the Bank for International Settlements (BIS):

1 market "depth", or the ability to execute large transactions without influencing prices unduly;
2 "tightness", or the gap between bid and offer prices;
3 "immediacy" or the speed with which transactions can be executed;
4 and "resilience", or the speed with which underlying prices are restored after a disturbance.

3.14 As in so much of economics, there is much confusion over stocks and flows. Assets are part of the stock, and their exchange the flow. The quantity theory of monetary flow is the usual statement:

$$MV = PQ \qquad [1]$$

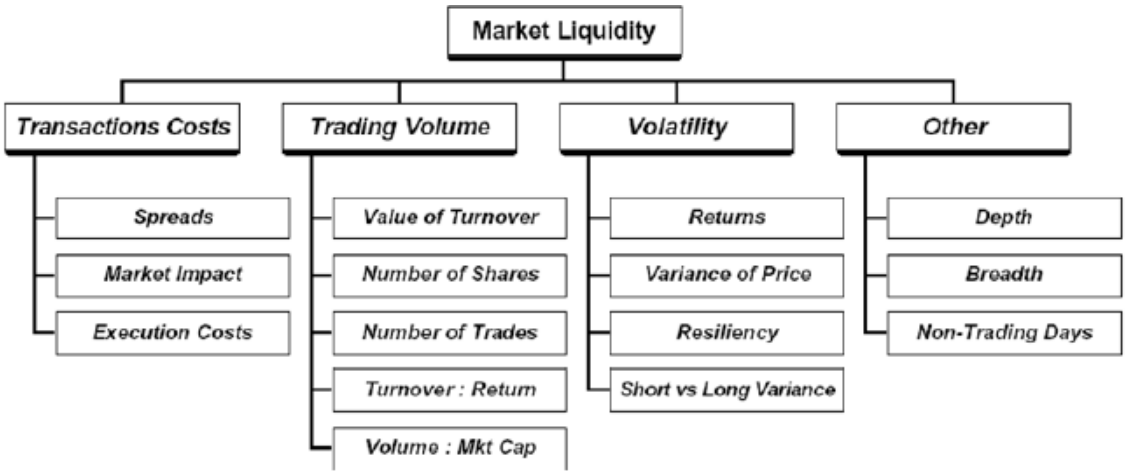
The product of a stock of money, M, and its flow, V, or velocity is equal to the product of the price of money, P and quantity of exchange, Q[29]. Many of the confusions over liquidity arise from the lack of distinction between a stock and a flow.

3.15 This relation also gives rise to the common classification of liquidity metrics as being either price or quantity in nature, but this taxonomy is incomplete. Many metrics, such as those related to volatility and resilience, defy such elementary classification. Figure 3.2 shows a taxonomy of market liquidity metrics (due to Holl and Winns, 1995). It should be noted that many of these measures themselves have further subtleties – for example, how market impact is separated from execution costs. Box 3.1 below discusses the range of metrics used in academic studies more fully. More than 80 different metrics have been used by academics.

3.16 We wish to draw a distinction between two types of market liquidity measure. The first are historic, based upon previous trading records (ex post metrics) and the second are based upon order flows, which can be considered current (real time) or possibly predictive in the short term. These can deliver markedly different information on liquidity conditions when estimated simultaneously in times of market stress. Order based measures can indicate diminished liquidity while historic trade measures may indicate good or even improved liquidity. The classic example is that during a crisis we may observe wide bid-offer spreads (an indicator of low liquidity) while simultaneously observing high transaction volumes.

[29] In an economic setting, the trouble with most versions of this identity is that Q is supposed to be output but does not include financial assets, which can lead to the spurious debate seen about the decline in velocity in recent decades, and actually missed that arguably monetary growth was generating asset price inflation.

Figure 3.2: A taxonomy of market liquidity measures – Holl & Winn 1995



3.17 Empirical comparison of different liquidity metrics shows them to be only weakly correlated with one another, which is to be expected to the extent that they are capturing different dimensions of liquidity. Meta-level analysis of samples of many different market liquidity metrics suggests that there are at least three different common factors present.

3.18 As liquidity costs relate to the purchase of liquid securities, the cost of liquidity principally arises with the stock (M). Velocity (V) is concerned with the efficiency of recycling of that stock, with more liquid securities being more efficiently recycled. Here payments systems and other market infrastructure may support V, but velocity is largely a question of participants' confidence and risk tolerance within a particular market infrastructure.

3.19 One metric that finds particular favour in official contexts, for example, the liquidity coverage ratio for banks, is the Amihud measure. This is the average of the ratio of the absolute price change in an asset to the volume traded. We suggest it may be best considered as a price impact metric.

3.20 Box 3.1 lists some of the more than 80 different measures of market liquidity that have been used in academic studies, and market liquidity is just one aspect of concern in this paper.

Box 3.1: Some measures of market liquidity

Without digging particularly deeply into the existing literature on market liquidity measurement, we can find the following:

- Frequently used measures include the volume and frequency of trades, the turnover ratio, the bid-ask spread, the mean transaction size, and the price impact of a trade (Fleming, MJ, 2003; D'Souza, C and Gaa, C, 2004).
- The negative of the autocovariance in price changes (Bao, J *et al, 2011*)
- Latent liquidity using bond holdings data on buy-side clients (Mahanti, S *et al,* 2008)
- Other measures, such as the number … of trades …and the number of market participants, are often regarded as readily observable proxies of market liquidity. (BIS, 1999)
- A combination of three proxies for liquidity, which were (i) the bond's age (ii) the bid-offer spread and (iii) the amount of bonds outstanding (Nunn, KP *et al*, 1986).
- Examples of direct liquidity measures are quoted bid–ask spreads, effective bid–ask spreads, quote sizes, trade sizes, quote frequencies, trade frequencies and trading volume (Houweling, P *et al*, 2005). We quote: " proxy this notion of liquidity with a yield dispersion statistic, which has not been used before in the literature", and "define the yield dispersion … as the standard deviation of percentage yield differences relative to the mean."
- In Ericsson, J and Renault, O (2001), a larger number of active traders competing for the same bond leads to a smaller price discount for illiquidity and thus a smaller yield premium. Alternatively, Gehr, AK and Martell TF (1992) and Jankowitsch, R *et al* (2006) argued that a larger number of market participants make it easier to trade a bond, because it is easier to find a counter party for a transaction and large orders can be split up into smaller parts without affecting the market price.

This survey is far from comprehensive and there are proxies for liquidity being elaborated at a faster pace today than at any time before the financial crisis. Given that caveat, the quotes above still yield sixteen proxies for market liquidity; in summary, these are:

a. Number of market participants,
b. number of trades,
c. volume of trades,
d. frequency of trades,
e. turnover ratio,
f. bid-ask spread,
g. mean transaction size,
h. price impact of a trade,
i. negative auto-covariance of price changes,
j. latent liquidity,
k. number the bond's age,
l. amount of bonds outstanding,
m. effective bid–ask spreads,
n. quote sizes,
o. quote frequencies; and finally
p. yield dispersion.

In combination, these proxies yield more than 80 variants which have been used in one or more studies.

3.21 The foreign exchange market is usually cited as the "most liquid" of all financial markets. The figures quoted are turnover or flow figures; approximately $4.5 trillion daily in early 2013. However, less attention is paid to the stock – in the case of US dollars, the external liabilities of the US banking system, which are approximately $4.5 trillion. All US liabilities held externally only amount to £12.2 trillion.

3.22 By any standard, this is a market with remarkable flow liquidity. Most of this flow is between dealer banks, and is exchange between insiders, which from the standpoint of the economy as a whole, is zero-sum. A reasonable theoretical economic policy goal would be to optimise outside exchange (i.e. exchanges between non-financial economic agents), so that all exchanges that are desired, and contribute to enhanced welfare, are accommodated. Put another way, very little foreign exchange activity is driven by any primary concern with trade or capital flows; some estimates place this "real economy" activity, the trade and investment capital flows, at less than 2% of the total.

3.23 Since a higher velocity of turnover is typically argued to lead to higher liquidity, higher turnover in markets has been interpreted as unconditionally beneficial. However, there is an important caveat here; as set out in 3.22 it is outside liquidity exchange which is the economic goal. We shall revisit this in section 4.5 in the context of high frequency trading.

3.24 We can also have large stocks of 'liquid' assets, but little exchange flow. This has been part of the post crisis problem, as central bank reserves have been hoarded. If the lack of exchange flow is not caused by low central bank reserves, then increasing them may be as effective as proverbially "pushing on a string".

3.25 Liquidity does possess some aspects of a public good; it is our primary financial risk management tool. It is worth noting that the liquidity stock is not fixed, though in normal times it is only slowly moving; if it were fixed, liquidity risk could only arise from the circulation or velocity dimension.

3.26 In his discussion of liquidity-based regulation J-P Zigrand (2014) observes: "*As with stability, liquidity has a public good aspect and is therefore inadequately provided for in a laissez-faire setting. The central bank at the core of the monetary system plays the role of liquidity provider of last resort through its repo and haircut policies. Together with the regulator (say, through leverage constraints and the like that act like a tax), the central bank can therefore nudge the composition of the balance sheets of financial institutions towards the internalisation of these externalities.*"

3.27 Liquidity is not created outside of the banking system, where this includes shadow banks. For example, listing private shares creates a liquid asset, but it does so by the exchange of liquidity in the IPO.

3.28 There is no law of the conservation of liquidity. Far from it, liquidity is remarkably asymmetric, in that it is slow to improve but can be lost or destroyed in an instant, in much the same manner as can trust.

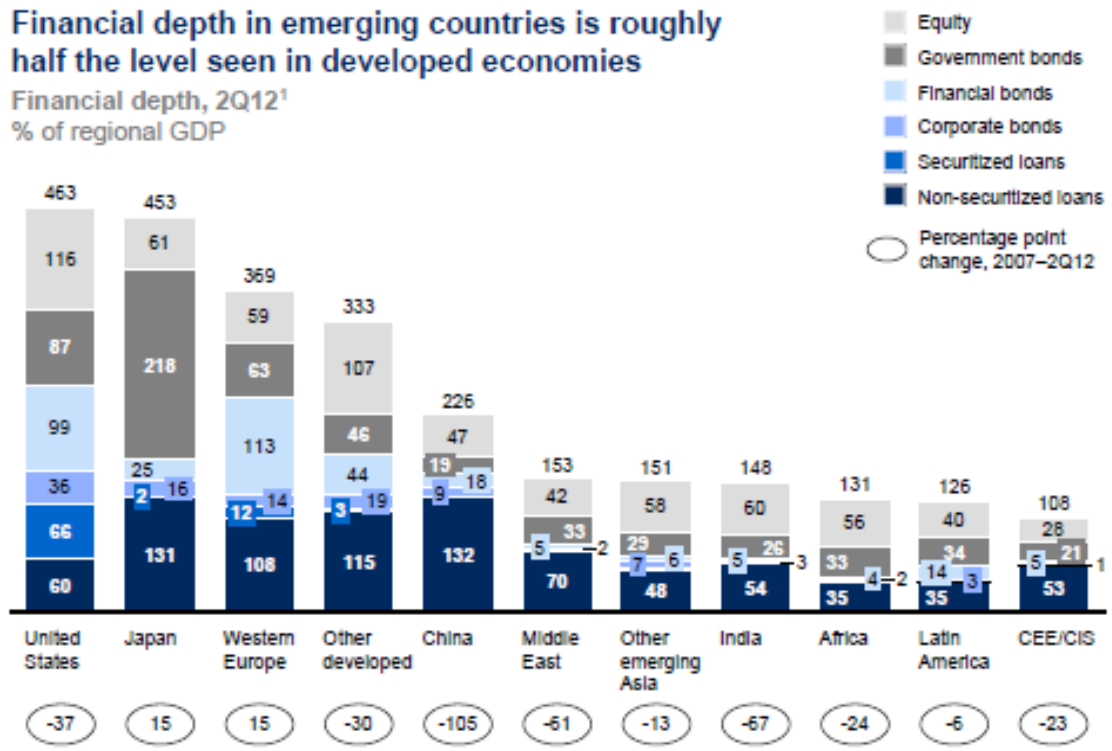
3.3 Financial depth and liquidity

3.29 Beyond the basic plumbing of payments and settlements systems infrastructure, the optimal quantum of liquidity depends on the financial depth and diversity of an economy and its investment institutions. Financial depth captures the importance of the financial sector relative to the economy. It is the size of banks, other financial institutions, and financial markets in a country, taken together and compared to a measure of economic output. The composition and magnitude of financial depth of various countries and regions as estimated by the McKinsey Global Institute (2013) is shown as Figure 3.3.

3.30 To quote from that McKinsey study: "*Expanded access to credit for households and businesses, more equity market listings by companies, and bonds issued to finance infrastructure projects are examples of healthy financial deepening. But financial depth can be also be inflated by such unproductive factors as equity*

market bubbles or unsustainable increases in debt and leverage. Overall growth in the value of financial assets does not automatically confer a positive effect on the real economy[31]*. Looking back, we can see that several unsustainable trends that propelled most of the financial deepening that occurred prior to the crisis, in both advanced and developing economies. Chief among these factors was the growing leverage and size of the financial sector itself. Some of what appeared to be robust growth produced exuberance at the time but ultimately proved to be illusory."*

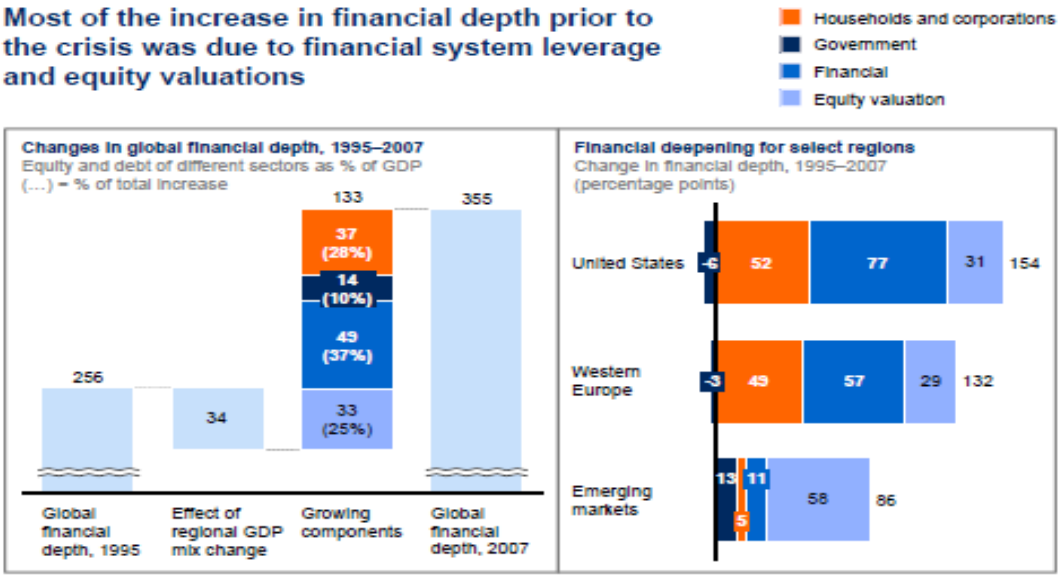
Figure 3.3: Financial Depth



3.31 The degree of financial development is often confused with the amount of bank lending. Where bank lending is for infrastructure and new productive capital investment, it can be expected to increase economic output and have no effect on inflation. However, lending to wasteful projects – the notorious bridges to nowhere - will add to demand but not output, with the result that this introduces inflationary pressures to the economy.

[31] Economic growth generates financial sector growth, rather than the reverse. Much literature on the relationship between finance and economic growth that shows a correlation gets causation reversed.

Figure 3.4: Changes in pre-crisis financial depth.

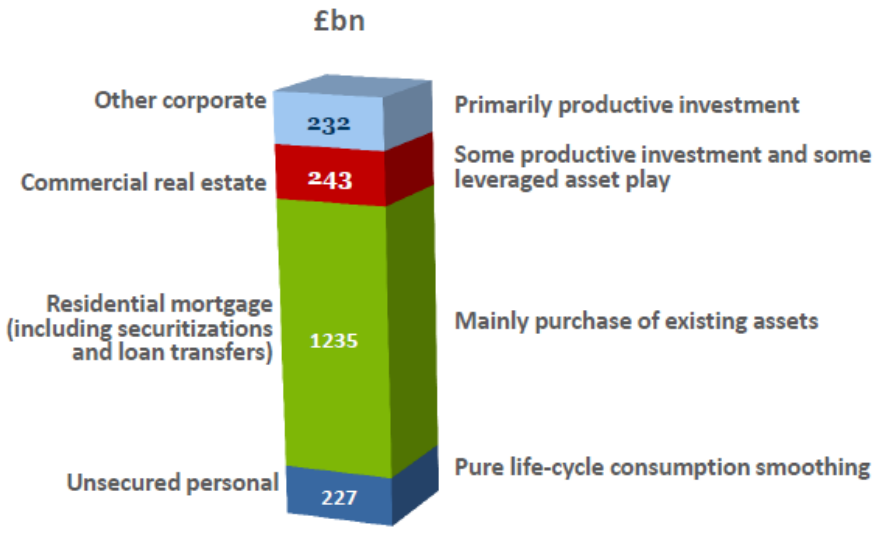


NOTE: Numbers may not sum due to rounding.
SOURCE: McKinsey Global Institute Financial Assets Database; McKinsey Global Institute analysis

3.32 Lending for the purchase of assets, either real or financial, will not directly introduce inflationary pressures – though it may through secondary routes such as wealth effects on consumption. This lending channel does little to increase the output of new goods or services, but asset prices may be chased ever higher. The art for the central banker is to curb this latter activity while maintaining the levels of productive investment.

3.33 Turner, A (2014) argues that financial theory oversimplifies the ability for debt and consequent financial flows to facilitate growth. He demonstrates that in reality debt can be extended in excess, and does not actually finance new investment, and then in crisis leads to an overhang resulting from the asymmetric reaction of creditors and debtors in a recession. His debt classification is illustrated further in Figure 3.5.

Figure 3.5: UK debt classification 2009



3.34 When the assets created by bank lending cannot be sold, other than at impaired prices, or fully re-financed in money markets, a liquidity crisis may be realised; the money previously advanced is recognised as lost and the bank will be more reticent about creating new money through loans.

3.35 It is often stated that highly developed capital markets are highly complementary to a developed banking system; that these markets enhance the financial stability of the banking system. This would be the case if the banking system were simply selling assets or raising capital in these markets from time to time. However, there is evidence of a "seatbelt effect"; where drivers drive faster and more dangerously after the introduction of compulsory seatbelts. In this case, banks adopt larger, riskier balance sheet management strategies that rely upon access to the ongoing and continuous presence of markets rather than internally held provisions of capital and liquidity.

3.4 Liquidity and liquidity risk

3.36 Riskis all about change in a variable. While liquidity itself has a cost, this may be compounded by uncertain changes in that cost, which can arise from either or both changes in the stock or the rate of its recycling or velocity.

3.37 Dealers may use active markets as a substitute for pricing models based on fundamental analysis. Active markets do not require commitment on the part of the dealer to an asset for the long term; to the dealer the market prices constitutes a real option on liquidity.

3.38 Many derivatives pricing models require trading in the direction of the price change of the underlying asset in their replication strategies. As the price of the underlying falls, so the hedge ratio declines and some part (Gamma) of the hedging holding is sold. The converse is true of price increases.

3.39 In this way these dynamic hedging strategies are akin to momentum strategies. A fall in the price does not introduce new buyers but rather further sellers, and an increase in the price not sellers but further buyers, in marked contrast to the elementary theory of supply and demand. Departures from any notion of fundamental value may be pronounced. Hedging strategies do differ from momentum strategies in that in order to maintain the hedge, the trend chasing behaviour is obligatory, while for momentum strategies it is voluntary.

3.40 Fundamental investors intend to work in the opposite direction, buying at low prices and selling at high. So the stability of the market system depends upon the proportion of fundamental and momentum investors present in it at any point in time.

3.5 Liquidity change

3.41 The link between previous liquidity and future liquidity in any security or class of securities may be extremely tenuous. Illiquid securities are usually extremely unlikely to become liquid; the few that achieve this transition typically take a long time to do so. The transition from liquid to illiquid is far more common, and means that there is a risk asymmetry associated with liquidity.

3.42 While the financial crisis offers some recent illustrations of such negative changes, there are many others. A prime example was the European floating rate note markets of the mid/late 1980s – these were predominantly subordinated bank debt, and very favourably treated in their recognition as regulatory capital. They traded in very large volumes at prices that were close to their par nominal values. There was limited distinction due to the creditworthiness of the issuer, or indeed the term of the securities. It was surprising but the majority of these securities came to be owned by banks, where they held as part of the banks' liquidity buffers.

3.43 The market slowly began to realise that these were in fact extremely risky bank capital instruments, and eventually there was a hiatus moment[32]; a day when prices collapsed and did not recover, and the note terms and institution specific credit considerations came to the fore in pricing and trading. The quoted bid-offer trading spreads moved from having been around 0.1% in price to being 5.0 % in price, round lot or normal trading size shrank as prices, in some instances, fell below 50% of nominal value. They moved from being the most liquid to being among the least liquid of all international bonds. This happened with no general securities market crisis .

3.44 Changes to the liquidity of securities issued by specific entities may also be triggered by entity-specific events. Most outstanding unsecured bonds will decline markedly in price and liquidity when leveraged buy-outs are mooted. There is considerable debate as to the extent to which the returns to buy-outs have come from other creditors of the company in these situations.

3.6 Keynes revisited

3.45 It is worth revisiting Keynes' quotation from 1.5 and explaining what is meant by "*It forgets that there is no such thing as liquidity of investment for the community as a whole."*

3.46 The sale of a security for cash requires that there be a counterparty in the market that is prepared to buy that which we wish to sell. As we have seen during the crisis, this may not be the case, even after the price has already been adjusted dramatically downwards. If many wish simultaneously to possess central bank money, asset prices must fall; the value of the stock of central bank reserves is far smaller than the market value of the stock of broader financial assets in normal confident times. The price falls in times of crisis are known as 'fire sales'.

3.47 'Fire sales' may be motivated by fear, but also arise as a consequence of regulation. Mark-to-market valuation of assets may induce fire sales of assets for insurance companies subject to a risk based capital rules. During the financial crisis, some money market funds found themselves taking possession in default of the collateral securities supporting their repo advances, but found that these assets were equities and long bonds, which were not eligible investments for them, and of which they then became forced sellers.

3.48 The liquidity of markets permits an investor to realise assets in short time scales; it is then no longer necessary to hold that bond or asset until receipt of coupons and principal is achieved. What matters now is not whether the bond can be expected to perform in due and contracted course, but the price at which it can be sold.

3.49 This has numerous consequences, from the decline in credit underwriting standards in the 'originate and distribute' business model, to accounting, and even in central bank monetary operations, such as quantitative easing.

3.50 Liquidity is the mechanism that allows market values to take such precedence in regulation and risk management as it eliminates the time dimension, i.e. the necessity to buy and hold. Selling a security reverses the maturity transformation undertaken by the investor. The difficulties that were observed with many proposed regulations, such as Solvency II for long-term guarantees, are rooted in this problem of time consistency and most evident at long time-scales.

[32] Though it is often possible to identify the specific cause of hiatus moments ex post, it is usually impossible to do so ex ante. This prompted Keynes' quip that markets may remain irrational for far longer than we can remain solvent.

4. Liquidity and markets

4.1 Much liquidity comes from realising assets for cash; and much trading happens in markets. Therefore, the natural next step in our journey is to look more closely at markets, how they operate, and the impact this has on liquidity for investors.

4.2 Markets cannot create wealth, though they can be important in its redistribution. In any primary sense, they do not create liquidity, and financial markets are now principally concerned with the negotiated exchange of property for liquidity among participants. Property and liquidity are finally exchanged when the transaction actually settles, and understanding those settlement processes and their limitations in a time of market stress is an important part of risk management. The growth of repo over unsecured interbank lending, despite regulatory pressures on balance sheet size, highlights how credit concerns among banks can lead to lower net liquidity flows.

4.3 In this chapter, we start in 4.1 by looking at liquidity in markets themselves, before moving on to consider how deals are settled through payments and settlements systems in 4.2. From there we consider market-makers in 4.3 and their role in providing liquidity both in normal times and at points of market stress, before having a more in depth look at the highly important repo market in 4.4 and conclude this section in 4.5 by considering the information held in market prices.

4.1 Liquidity in derivative and cash markets

4.4 We distinguish between two different types of market – cash markets, such as stock exchanges or bond markets, and derivatives markets (futures and similar). Cash markets clearly are concerned with exchanging property for immediate liquidity – modified only by the clearing and settlements time cycle.

4.5 Derivatives markets are in fact concerned principally with access to money in future, i.e. the insurance aspect of liquidity. The highly traded interest rate swaps which so many refer to as extremely liquid in fact involve no transfer of funds at contract inception (and usually no transfer of collateral unless there is a material mismatch in the credit risk status of the counterparts) if the contract is fairly priced. This is a “liquid” market involving no immediate exchange or transfer of liquidity; were it not for counterparty credit considerations, we should expect such markets to expand almost without limit. As subsequent times, the swap will have an explicit value that reflects the changes in conditions since inception.

4.6 Many other markets, such as futures markets, by design involve only trivial transfers of liquidity or collateral at transaction inception. These are the initial and variation margins. These contracts are all concerned with future liquidity and are driven by change in price – the liquidity flows occur under variation margin or credit support agreements. These are markets designed for access to exposure to asset price moves, rather than for access to the cashflows of the underlying asset in the long term.

4.7 The usual presentation of the origins of futures and derivatives markets such as the futures exchanges for agricultural products is that they allow a transfer of risk from producer to consumer by means other than physical delivery. It seems that, in many instances, the transfer is in fact to the financial sector rather than consumer, but it is argued that this supports investment. Nonetheless, these instruments, which draw their value from changes in some underlying, are risk management tools.

4.8 However, the farmer hedging his crop in the field has already made the investment. It may be true that, in the absence of the ability to hedge the farmer may not have made the investment in planting crops in the first place, but that is a case of the farmer being prepared to make an investment only if risks can be hedged in the short term.

4.9 To consider a further example, when the oil price underwent a large and sustained rise in recent years, airline hedging strategies merely delayed the inevitable. They may have lessened the immediate blow, but they could not mitigate the fact that the airline industry is highly exposed to the oil price. No airline could hedge that exposure out for its corporate lifetime. The decision on the hedging strategy was largely one around 'value' of the price being locked into, which did have an impact on business plans and shareholder value, albeit not necessarily on the fundamental value of the airline over the long term and its strategy.

4.10 Markets are venues (real or virtual) for the negotiated exchange of property, where money is the medium of exchange. It is as well to remember that financial markets are quite limited in their potential –there is a tendency, as exemplified by James Carville's desire to be reincarnated as the bond market[33], to overstate what markets can do, usually anthropomorphising them in the process.

4.11 Markets cannot create wealth, though they can be important in its redistribution. They may facilitate through their exchanges the creation of wealth among outside actors, for example, by allowing greater specialisation in production among these actors. In any primary sense, they do not create liquidity – they are merely one of the conduits through which the economy's monetary savings are brought to the users of those savings.

4.12 These users include households, government and industry. In a secondary and minor sense, markets may create liquidity through the higher prices that may prevail – the money stock would be higher. However, the majority of their action is through efficient organisation of the liquidity available, known in the economics jargon as co-ordination – a velocity or distribution effect.

4.13 The economic benefits, however, accrue from efficient outside allocation, not necessarily from increased activity among insiders. In fact, markets can only do what we, collectively, permit them to do. However, they can on occasion be the bearer of messages that are most unwelcome.

4.14 Markets have two closely related functions; price discovery and coordination. Price discovery is concerned with the mechanism by which information is reflected and revealed, while coordination might alternately be described as liquidity transfer. As noted already, it is hard to distinguish information effects and liquidity. To give a concrete example, is the realisable price of the asset low because the fundamental value is low, or because it is illiquid and it is hard to find a seller. There is value in knowing the answer to this, particularly when many markets are concurrently illiquid, in terms of devising a trading strategy that meets liquidity requirements now with the minimum destruction of value.

4.15 In recent times, regulators in Europe have encouraged the development of new exchanges and competition between exchanges in the belief that this will correct a perceived trading cost problem. However, unless these competing markets bring new investors and sources of liquidity, this action will fragment liquidity and increase execution costs. Even the increased activity due to arbitrage between market venues is spurious in that arbitrage will only be undertaken if profitable to the arbitrageur.

4.16 The question of liquidity fragmentation across venues is highly contentious, revolving around how much exchange activity can be accommodated by a given amount of liquidity, and is believed to be non-linear. This view holds that a market with liquidity of 2X will efficiently accommodate more exchange activity than two markets each having X. Order matching algorithms and practices are important determinants of how effectively markets use the liquidity they have. The argument against market fragmentation also reflects a widely held trader belief that liquidity attracts liquidity.

[33] Carville said: "I used to think if there was reincarnation, I wanted to come back as the president or the pope or a .400 baseball hitter. But, now I want to come back as the bond market. You can intimidate everybody."

4.17 Financial markets are now principally concerned with the exchange of liquidity for property among participants; their role in raising new money for investment has declined to subsidiary status. Even most initial and later public offerings have the raised funds being used to "cash out" existing investors rather than finance new projects. This refinancing role extends to the replacement of maturing debt and was significant in the case of the European sovereign debt crisis. The inside exchange activity though may not fulfil a price discovery role for those external users of capital concerned with productive investment and consumer finance.

4.2 Payments and settlements systems

4.18 The place where money actually changes hands isthe payments and settlements system. No transaction is complete in the sense of final liquidity transfer until it has settled. This is a nicety quite often overlooked by front office personnel.

4.19 The BIS Committee on Payment and Settlement Systems (CPSS) publishes periodically the standard reference work known as the "Red Book" which covers, in its two volumes, details of the systems of the major economies. In the foreword to the most recent edition, it notes: "*Properly functioning payment systems enhance the stability of the financial sector, reduce transaction costs in the economy, promote the efficient use of financial resources, improve financial market liquidity and facilitate the conduct of monetary policy. In recent years, issues relating to the economic efficiency and financial risks of all types of payment arrangement have come to the fore.*" The Red Book includes coverage of clearing and securities settlement systems.

4.20 It is worth noting that a number of changes to systems and processes have been introduced in the post Lehman period. The Red Book also covers salient features of a number of other international arrangements, such as American Express, SWIFT, Visa, Mastercard, CLS, Clearstream and Euroclear.

4.21 SWIFT is not strictly a payment system; it supplies secure messaging services and interface software to aid automation of financial transaction processes. It also constitutes a forum for financial institutions to address issues on mutual concern in financial communication.

4.22 For payments, almost 80 clearing and settlement systems rely on SWIFT for secure messaging connectivity and common message standards. SWIFT is used by market infrastructure systems for the clearing and settlement of both high-value interbank payments (such as Europe's TARGET2 RTGS) and low-value payments (such as automated clearing houses or ACHs). It is also used by the multicurrency cash settlement system CLS.

4.23 In the securities sector, SWIFT is used particularly for securities reporting by the securities market clearing and settlement infrastructures. Exchanges, matching utilities, clearing houses, CCPs and (international) central securities depositories ((I)CSDs) all use SWIFT. It is also used for the exchange of information between market players and regulators or financial authorities.

4.24 SWIFT traffic flows are indicators of the level of global activity in financial services. Geographically its message flows are 67% Europe, Middle East and Africa, 20.4% Americas and 12.6% Asia. The type of message is 49.4% payment, 43.4% securities and 5.8% treasury – just 1.1% of messages are trade finance related.

4.25 Payments systems around the world are now predominantly overseen by central banks. It appears that this is in part because of their role as lender of last resort within a national system, with responsibilities for the integrity of the banking system. However, it should be recognised that bankers' clearing-houses have often arisen without active participation of the central bank, since clearing-houses improve the efficiency and profitability of banks that accept claims upon one another.

Box 4.1: Payments Systems in the UK (Bank of England)

CHAPS
CHAPS is the United Kingdom's high-value payment system, providing real-time gross settlement (RTGS) of sterling transfers between members. CHAPS is operated by CHAPS Clearing Company (CHAPS Co). CHAPS Co is owned by the 19 members of CHAPS.

CREST
The CREST system (CREST) is the securities settlement system (SSS) for UK gilts and money market instruments denominated in sterling, euro and US dollars, as well as UK and Irish equities. Sterling and euro transactions are settled on a gross Delivery versus Payment (DvP) basis. CREST is operated by Euroclear UK and Ireland (EUI), which is a subsidiary of the Belgium-based Euroclear group. The Euroclear group is owned and governed by its users.

Bacs
Bacs processes direct credit and direct debit payments on a three-day DNS cycle. Bacs is operated by Bacs Payment Schemes Ltd. Bacs Payment Schemes Ltd is owned by the 16 members of Bacs.

FPS
The Faster Payments Service (FPS) is a DNS system for standing orders and electronic retail transactions, including transactions generated in telephone and internet banking. The system supports transfer of value between retail customers' accounts in near real time, 24 hours a day, and seven days a week and settles three times per working day. FPS is operated by Faster Payments Scheme Limited (FPSL). FPS is owned by the ten members of FPS.

LCH
LCH.Clearnet Ltd is the largest central counterparty (CCP) in the United Kingdom, clearing a wide range of exchange-traded and OTC products, including interest rate swaps (SwapClear) and fixed income (RepoClear). It makes and receives cash payments through the 'Protected Payments System'. LCH Ltd is fully owned by LCH.Clearnet Group Ltd. LCH.Clearnet Group Ltd is a private company, limited by shares and owned by a number of exchanges and users.

LCH.Clearnet Group Ltd and London Stock Exchange Group (LSEG) have recently agreed terms that will result in LSEG taking a stake of up to 57.8% in LCH.Clearnet Group Ltd, subject to certain conditions. Other exchanges and users of LCH will retain at least 42.2%. The deal is expected to conclude in the second quarter of 2013.

ICE
ICE Clear Europe is a CCP that clears energy derivatives and credit default swaps (CDS). Its payment system is the 'Assured Payment System'. ICE Clear Europe is operated by ICE Clear Europe Ltd, which is wholly owned by ICE Inc., which is publicly listed in the United States.

CLS
CLS provides a Payment versus Payment (PvP) settlement service for foreign exchange transactions in 17 currencies including sterling. CLS also handles payments for certain non-PvP transactions, such as non-deliverable foreign exchange forwards and some types of credit derivatives. CLS is operated by CLS Bank International, which is owned by its members.

4.26 The CPSS and IOSCO (International Organisation of Securities Commissions) (2012) have published a widely adopted set of principles for financial market infrastructures. The principles cover the legal basis, governance, comprehensive risk management, credit risk, collateral, margin, liquidity risk, settlement finality, money settlements, physical deliveries, central securities depositaries, exchange of value settlement systems, participant default rules and procedures, segregation and portability, general business risk, operational risk, access and participation requirements, tiered (or correspondent) participation arrangements, Financial Market Infrastructure links, efficiency and effectiveness, communication procedures and standards, disclosure of rules, key procedures and market data, and finally disclosure of data by trade repositories.

4.27 As required by part 5 of the Banking Act 2009, the Bank of England publishes annually a Payment Systems Oversight Report. This covers the seven recognised payments systems operating in the UK. Box 4.1 contains descriptions of these systems and their functionality. Table 4.1 shows the average daily numbers of transactions and the average daily turnover value.

4.28 To give these figures some context, UK GDP for 2012 was approximately £1.5 trillion, and at year-end 2012, reserves held by the commercial banking system amounted to £271 billion. This latter figure has been inflated by quantitative easing. These transactions volumes and values also do not take any account of transfers between clients within any bank (contra accounts).

4.29 Approximately 45% of transactions are made by clearing house member banks on behalf of indirect participants, under correspondent banking arrangements. To limit the potential for systemic risk under these arrangements, new rules will require very large indirect participants to participate directly. These rules are: if the daily activity exceeds 2% by value of the total processed by CHAPS or if the indirect participant's activity

exceeds 40% of the direct participant bank, without sufficient mitigation of the risks created between the settlement bank and indirect participant.

4.30 CHAPS is a real-time gross settlement system, while BACS and FPS are deferred multilateral net settlements systems.Though deferred net payments systems require less liquidity than RTGS arrangements, they may also allow unacceptable exposures between members to develop in the course of a settlement cycle. Collateral is required to be posted to offset these exposures; for much of 2012, this amounted to £4.5 billion, around 0.1% of the annual amount settled.

Table 4.1: UK Payment Systems

	Average Volume	Average Daily Value (£ Millions)	Bank Members	Payment Types
CHAPS (£)	134,667	284,591	19	Settlement financial market transactions CLS Pay-in & Pay-out House Purchases
BACS	22,287,266	16,318	16	Salaries & Benefits Direct Debit & Credit
FPS	3,218,619	2,452	10	Telephone & Internet banking Single immediate and forwarded dated payments Standing Orders
CREST (£)	164,055	420,561	15	Settlement of gilts, equities and money market instruments including BoE open market operations and repo more generally
LCH Clearnet (£)	39	644	14	Net Margin flows Commodity delivery payments Cash Settlements Default Fund contributions Coupon Payments
ICE (£)	21	78	6	Net Margin flows Commodity Deliveries Cash Settlements Default Fund contributions
CLS (£)	45,457	212,588	62	Settlement of Foreign Exchange

4.31 Given the need to recycle liquidity within any day, it is clear that the management of throughput is a major concern in RTGS systems. There are incentives for any participant settlement bank to receive payments at all times but not make any out until late in the day. These could result in clustering of payments around the end of day and increase vulnerability to operational events at those times. These problems are currently addressed by throughput targets, but further liquidity saving mechanisms are now being implemented in the UK CHAPS system. Known as the liquidity saving mechanism (Davey, N and Gray, D 2014), this is an algorithm that matches and offsets flows; it is estimated to have reduced the liquidity float needed in CHAPS from slightly above £21 billion to a little more than £16 billion.

4.32 The US operates a system of intraday liquidity pricing but the UK does not. However, there is evidence (Jurgilas, M and Zikes, F, 2012) that intraday liquidity is priced in the money markets, not just in the UK but across Europe. Their work indicates that the price of intraday liquidity was low prior to the crisis but increased tenfold during it, lending support to the idea that the crisis was at least in part a liquidity crisis.
We quote: "*Intraday liquidity can also be obtained from the central bank. The Bank of England provides interest free collateralised intraday overdrafts to settlement banks (direct participants of the UK large-value payment system (CHAPS)). But the implicit cost of pledging collateral with the Bank of England should provide*

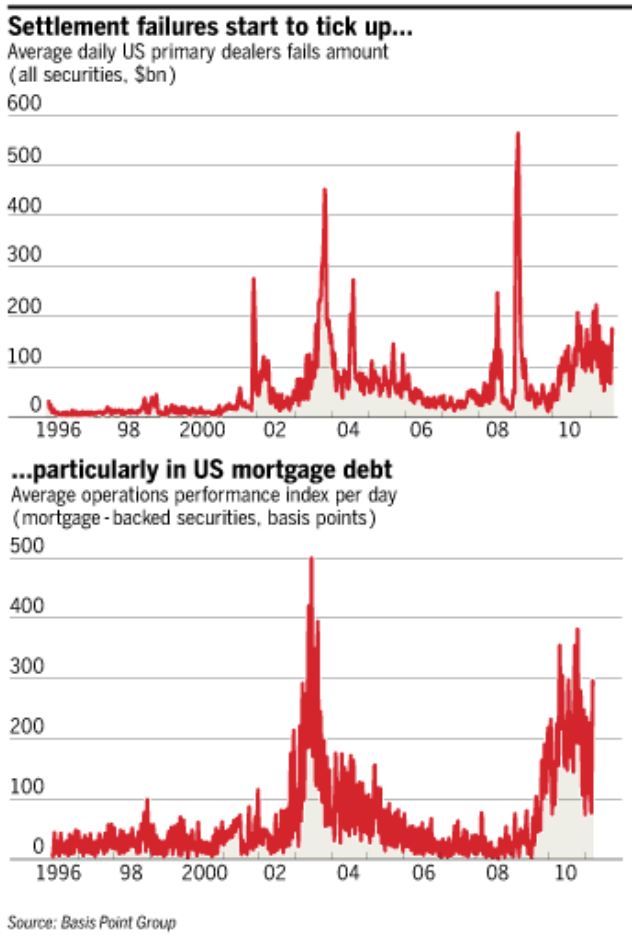
the upper bound for the intraday liquidity cost. Since the opportunity cost of pledging collateral is not observed, the difference between interest rates charged for overnight loans at different points during the day can serve as an indicator of the opportunity cost of collateral used to obtain intraday liquidity from the Bank of England."

4.33 Some high frequency trading strategies exploit the availability of effectively free intraday credit by taking gross positions that far exceed their available funds. These strategies rely upon reducing positions by close of business on any given day.

4.34 In the US, there has been considerable discussion of the practice of tri-party repo (see section 4.4) managers unwinding positions at the beginning of each day, which can place strain upon payment system and securities settlement system flows.

4.35 The problem of settlements does not end with the cash movements; there is also the question of failures to deliver (or receive). These have been particularly problematic in the US, as is shown in Figure 4.1 below.

Figure 4.1: US Securities 'Fails'



Source: Basis Point Group

4.36 Even though attempts have been made, such as the imposition of penalties on fails, to resolve these issues, they do not seem to have had much effect in countering the effects of very low interest rates. In April 2011, the European Central Bank published a report entitled "*Settlement Fails: Report on Security Settlement Systems (SSS) measures to ensure timely settlement.*" which discusses the issues and possible remedies extensively.

4.37 The potential difficulties with payments were highlighted by the failure of Bankhaus I.D. Herstatt, which was forced into liquidation by the Bundesbank in June 1974, at a time of day when a number of banks had made Deutschemark payments to Herstatt but were awaiting the payment of US dollars from it. The continuous linked settlement system (CLS) can be seen as a solution to these foreign exchange payment issues.

4.3 Market-making

4.38 Most exchange rules and conventions can be seen as mechanisms to facilitate exchange – to minimise the costs and effort of overcoming information imperfections and asymmetries. These are intended to improve coordination. As already noted, a market that was solely reliant upon outside order activity would be a poorly functioning market, suffering a variant of the double coincidence of wants that hamstrings barter trade. The response has been to introduce market makers (specialists, jobbers, primary dealers) as insiders to facilitate a higher level of transactions among outsiders. Market makers usually have responsibility for ensuring the orderly functioning of the market. They may be granted some privileges and concessions in return.

4.39 It is worth noting the roles that primary dealers in government securities are expected to fulfil. Ostensibly, their role is merely to ensure that government debt issuance is achieved in a cost-effective manner:

- acting as a channel between debt manager and investor in the primary market (for example, by participating in auctions);
- performing as bookmakers and distributors by having dealers that canvas investors' interest and distribute securities ahead of auctions through when-issued markets;
- acting as providers of immediacy of liquidity to primary and secondary markets;
- acting as providers of asset transformation and market-making services by being willing to hold inventories of government securities and allowing investors to swap between various outstanding issues of government securities on a continuous basis to help bring liquidity to the market;
- promoting continuous markets and efficient price discovery by organising dealers within an appropriate market structure that can encourage efficient price discovery;
- acting as agents and relationship managers educating investors about the attractiveness of government securities as an investment; and
- being advisors to the government by formulating and adopting appropriate strategies for the development of products and markets.

4.40 Some markets do exist seemingly without market makers. The old style open outcry trading pits of the futures and options markets were one example, though these had many participants, such as locals and "scalpers" whose primary function was to introduce liquidity. Many securities markets are now organised as computer network systems. In these markets, it is not uncommon for some participants to assume an active trading, quasi market-maker role.

4.41 Some fund managers seek to generate excess returns (alpha) by "providing" liquidity to the market; these managers can in fact only provide liquidity to the extent that they already have this liquidity in hand or are able to create credit. In only too many cases, "providing liquidity" actually means hyper-active trading. There is a related literature on exploitative trading practices in times of financial instability, known as "cash in the market" pricing. Here the trader hoards liquidity in order to be able to profit from fire sales in times of distress. Baron Rothschild made a fortune buying in the panic following the battle of Waterloo, and apocryphally said "Buy when there is blood on the streets, even if the blood is your own".

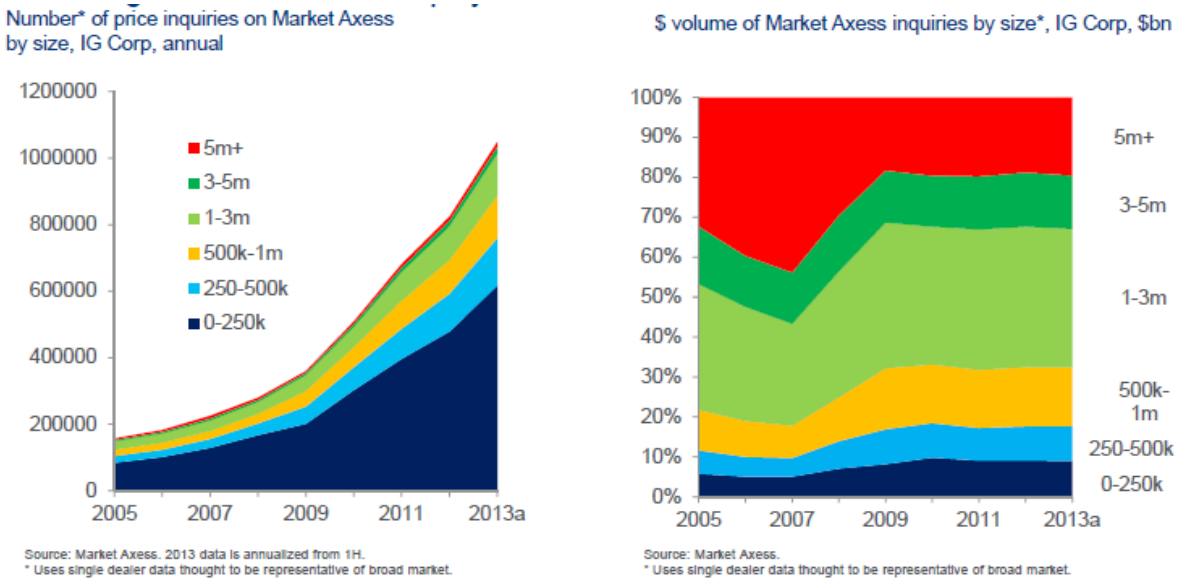
4.42 Markets without any physical presence but organised over computer networks are usually anonymous in nature, with the counter-party risk being accommodated by a central counterparty or the market sponsor. Anonymity is often a desirable characteristic from the perspective of dealers, who may not wish others to be aware of their activity and trading inventory positions. But such anonymous markets are usually inflexible and they do not enhance an important aspect of a flexible market - trust. With trust among market participants, unusual transactions may be accommodated at minimal cost and effort. Liquidity in these markets, which often involve bilateral undertakings, is in a sense broader than in the anonymous variant. One positive aspect of anonymous markets is that participants will not suffer discrimination, which we return to in section 4.5.

4.43 One of the ambitions of the European Markets in Financial Instruments Directive was to encourage the development of competing venues for financial securities exchange. The result has been a proliferation of (mainly equity) exchanges and crossing networks – and the introduction of a new lexicon, including "lit" markets and "dark pools". It is clear that this fragments liquidity among the various venues, though it does bring arbitrage opportunity between venues for the swift and agile.

4.44 It appears that the clientele of crossing networks, or at least the orders that they show to these venues, differs substantially from that of the markets more broadly. For many networks, it is also far from obvious what proportion of orders submitted are successfully executed. The numbers of orders being submitted to the more developed bond networks has grown exponentially, but these orders have tended to be far smaller than are seen in the traditional government and corporate bond markets. Figure 6.8 shows the recent development of transaction size in the US Treasury market.

4.45 The recent closures of some electronic systems suggests strongly that not all have been successful in capturing business. Figure 4.2 shows order (inquiry) growth and the mix of inquiry size for one of electronic network, Market Axess.

Figure 4.2: Number and Size of Price Inquiries on Market Axess.



4.4 Repo markets and financing

4.46 The structure and form of ancillary markets can greatly influence what is traded in the real or virtual principal marketplace, and may be well illustrated by the European repo markets. In this sub-section of the paper we draw heavily on the 26th International Capital Market Association semi-annual survey (2014), and all data and statistics are drawn from this survey unless we have stated otherwise.

4.47 Repo markets facilitate trading and market liquidity in two distinct ways. They are sources of funding liquidity for long inventories held by dealers, and they are sources of securities borrowing, which is necessary for efficient settlement of short sales. This borrowing allows tight offer prices in market quotations. Securities serving as collateral in repo are outside of the formal bankruptcy process in most but not all jurisdictions, and the collateral can be sold on the event of a counterpart default.

4.48 Tight price quotations improve liquidity by lowering effect transaction costs. While many think of liquidity as being only the ability to sell a security easily when desired, it is as important from an economic perspective that investors should be able to deploy capital into productive investments in a speedy and cost effective manner.

4.49 By any reckoning, these are very substantial markets - €5.5 trillion versus a pre crisis peak of €6.8 trillion, with the current figure being made up as to 49.2% repo and 50.8% reverse repo[35].. Approximately 10% of trading in recent times has been securities lending rather than repo or reverse repo. Trading takes place in one of three markets as is shown in Table 4.2 below:

Table 4.2: Repo Trading Analysis

	December 2013		June 2013		December 2012	
	users	share	users	share	users	share
direct	68	53.2%	65	52.3%	71	50.9%
of which tri-party	41	9.9%	37	9.6%	41	9.5%
voice-brokers	52	15.1%	53	14.6%	58	16.3%
ATS	52	31.7%	53	33.1%	52	32.8%

4.50 Repo has provided an example of rivalrous “crowding out”. As concerns over the credit standing of banks has risen, notwithstanding a price differential in favour of unsecured deposits, the secured form of repo has dominated activity as a growing proportion of overall lending.

4.51 Repo takes two possible legal forms where either the securities are pledged or there is full transfer of title. It appears that new regulations will distinguish between these transaction forms to the detriment of the pledged form. The detail of the form is important if the fraudulent use of particular collateral to support multiple loans is to be avoided; this was an element of the Maxwell scandal and more recently in China, where warehouse deposit receipts have been used. This fraudulent use is different to rehypothecation, which is the recycling of the collateral by the lender of funds.

4.52 In Table 4.2, ATS refers to various automated trading systems, such as MTS, BrokerTec and Eurex Repo. In common with all surveys, this may not capture all aspects of market behaviour. For example, all tri-party repohas anecdotally been reported as growing at far faster rates than evident from this sample and as

[35] This categorisation, which is surprising at first sight since we should expect repo to be equal to reverse repo, arises from the manner in which the statistics are compiled. The 68 reporting dealers are asked to report the sum of their repos and the sum of their reverse repos. If these dealers were the entire market, the difference between repo and reverses would be interpretable as the net position, in this case, one of securities borrowing and rather small at 1.6% of the total activity.

being driven by greater participation by a wider range of customers, notably non-bank financial institutions. It is also perhaps affected by the ability of the banks in this sample to tap the fixed rate full allotment facility at the ECB to satisfy their year-end requirements. It is clear that many dealer participants use many and even all of these venues, as is illustrated in Table 4.3:

Table 4.3: Numbers of participants in different trading venues

	Dec-13	Jun-13	Dec-12	Jun-12	Dec-11	Jun-11
ATS	52	53	52	45	47	44
anonymous ATS	47	45	44	37	39	37
voice-brokers	52	53	58	51	54	48
tri-party repos	41	37	41	34	39	36
total	68	65	71	62	64	58

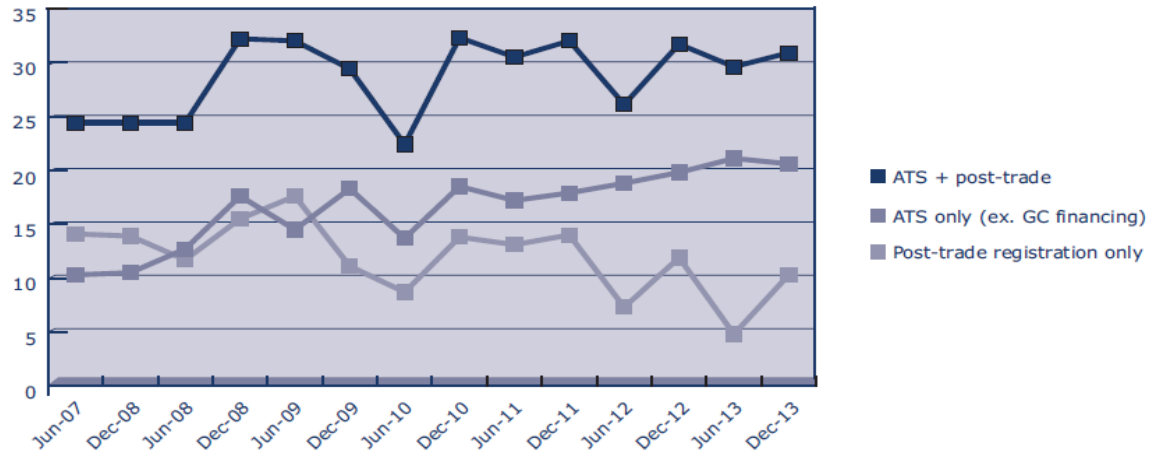
4.53 Repo is very much a cross-border and multicurrency business. The geographical analysis by venue is shown as Table 4.4, where WMBA is the share of voice brokers. It is evident that a greater share of cross-border activity takes place within automated trading systems (ATS) compared to domestic business.

Table 4.4: Geographic spread of activity by venue

	main survey	ATS	tri-party	WMBA
domestic	26.1%	31.3%	42.3%	47.0%
cross-border	48.9%	68.6%	57.7%	53.0%
anonymous	25.0%			

4.54 Some pronounced trends in the form of transaction have also been evident, notably the increasing use of Central Counterparties, fostered by regulatory change, as is shown in Figure 4.3 below. The increasing use of CCPs is being promoted by regulatory action, although it is worth noting that the Bank of England's Andrew Hauser (2014) was keen to point out that it is a myth that regulators and central banks want to kill off repo.

Figure 4.3: Use of CCPs



4.55 The differences between the various forms of trading venue are most evident in the maturity or term of repo undertaken, as is shown in Table 4.5. It is evident that some of these differences are due to the business model of the participant, for example, the high level of open repo undertaken by the tri-party repo

agents. It is also evident that some more complex transactions, such as forward start transactions, require negotiation and human intervention and are poorly suited to automation. By contrast, overnight repo appears highly suited to automated systems, and these dominate activity in these systems.

Table 4.5: Maturity analysis in different venues

	main survey	ATS	tri-party	WMBA
1 day	19.9%	83.1%	11.2%	3.9%
2 days to 1 week	15.8%	11.2%	7.4%	6.1%
1 week to 1 month	22.0%	2.5%	6.3%	14.2%
>1 month to 3 months	16.6%	1.5%	8.4%	18.2%
>3 months to 6 months	4.6%	0.3%	9.3%	5.0%
>6 months to 12 months	3.1%	0.4%	2.4%	5.9%
>12 months	3.1%	0.3%	1.0%	0.4%
forward-start	8.8%	0.6%		42.6%
open	6.2%		54.0%	3.8%

4.56 The ICMA survey also provides a tabulation of the average "haircut" by type of asset for activity undertaken by tri-party repo agents, which is reproduced as Table 4.6. Haircuts limit how much cash may be accessed via repo, giving a liquidity trade-off between repo compared to outright sale. A more complete analysis would also consider the interest rate applied to these different forms of asset, which would help illuminate the degree of supply and demand for specific securities.

Table 4.6: Haircuts for various types of collateral.

(weighted average haircuts)	Dec 2013	June 2013	Dec 2012
government securities	2.7%	2.6%	2.7%
public agencies / sub-national governments	2.3%	2.2%	2.6%
supranational agencies	2.5%	2.7%	2.5%
corporate bonds (financial)	5.8%	4.8%	5.5%
corporate bonds (non-financial)		6.3%	
covered bonds	3.1%	2.8%	2.3%
residential mortgage-backed	10.9%	8.6%	9.2%
commercial mortgage-backed	8.2%	9.5%	8.1%
other asset-backed	8.0%	7.4%	6.8%
CDO, CLN, CLO, etc	7.1%	7.6%	7.5%
convertible bonds	13.1%	4.4%	6.9%
equity	6.0%	5.8%	5.5%
other	6.4%	3.3%	6.7

4.5 Market prices and information

4.57 Markets have advanced somewhat since Democritus described them as "places where men meet to deceive". However, much of the activity in financial markets is concerned with price performance in the short-term. It is the primary source of market volatility, which is for many, risk. In passing, we would argue that risk management ought to include a wider appreciation of tail events. The short-term performance of markets is negatively correlated with real economic activity but the long-term positively. At the time of writing (16

October 2014), the FTSE100 price index is well below levels seen 15 years ago, so the long term can clearly be a long time coming.

4.58 With this in mind, it is surprising to see economic growth rates so widely advanced as supporting evidence for analysts' recommendations to buy, hold or sell. It is questionable to what extent economic growth translates to income and earnings as well as to distributions to investors.

4.59 Many institutional investors now use algorithms to execute their market orders in stock markets. The trend is less pronounced in government bond markets. This use of algorithms to spread orders and disguise them from the market apparently stems from dissatisfaction with previous limit order methods. In other words, the use of algorithms by institutional investors was prompted by a lack of trust in the market trading mechanism which prevailed at the time. This is an attempt to improve execution and lower transaction expenses by lowering market impact.

4.60 The important point about these investor orders is that they, more than any other, should be carrying information that is price relevant. To protect themselves, they are disguising these orders, or at the least, settling for complex averages of prices and volume. This hardly improves the functioning of markets in their economic context.

4.61 The rise of high frequency trading has been remarkable. By many reckonings, high frequency trading now accounts for 50% or more of all trading activity in many equity markets. Such algorithmic trading is also prevalent in foreign exchange markets. The defence of these automated strategies is that they improve execution for the investor and improve the liquidity of securities in these markets. It is far from clear that this defence is true.

4.62 They certainly increase the number of transactions but the average transaction size has also decreased. An open question is whether they increase or decrease the volume of transactions of economically relevant transactions from real economy entities. A further test is the level of costs incurred by these real economy investors in achieving their desired asset allocation – their use of algorithms to execute orders suggests that it has not improved them.

4.63 Much has been said about the occasional large and erratic price movements in equity markets and the role of high frequency trading. The "Flash Crash" (where on 6 May 2010 the Dow Jones industrial average dropped about 9%, before recovering minutes later) was the doyenne of these until the recent 150-point drop triggered by a mischievous tweet about bombs having exploded in the White House, where algorithmic trading was apparently also prominent. More recently still, on 15 October 2014 there were "mini flash crashses" in the S&P 500 future - and the S&P 500 future traded significantly different to the underlying cash market.

4.64 One of the defences to the criticism that algorithmic trading based upon price movements brought no new information to markets, but rather would distort that information present through exaggeration and amplification of noise, was that some of these algorithms are "intelligent". By this, it was meant that some algorithms have been written to interpret textual news feeds. Apparently, these algorithms contributed to the most recent White House bomb scare tweet episode.

4.65 Most high frequency traders are thinly capitalised – they do not bring any material liquidity stock to a market. Many, perhaps most, maintain no positions overnight. The claim of liquidity enhancement, if valid, must rest on the increased turnover velocity that they may bring.

4.66 It seems probable that small retail traders may benefit from the low order sizes of high frequency traders. However, when an institution wishes to trade in size, the high frequency traders do not provide enhanced liquidity for them.

4.67 However, as was noted earlier, it is possible that increasingly frenetic trading in an effectively fixed free float is what is occurring here, with little or no impact on real economy investments, other than through the subsidiary and secondary price and valuation mechanisms.

4.68 Two questions really need answers:

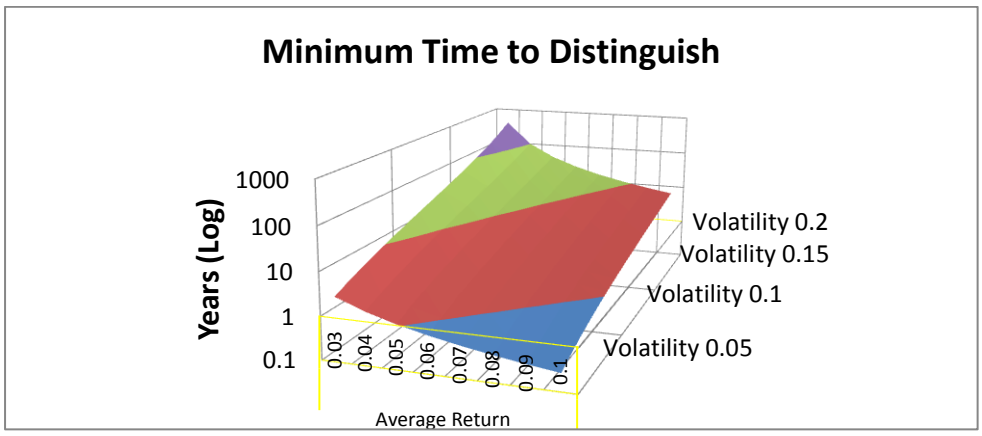
- Where does the settlement cash liquidity come from?
- If high frequency traders brings liquidity to markets, why do they operate only in liquid stocks when the illiquid offer higher premiums?

It would seem likely that they operate in stocks that are already liquid precisely because they themselves have needs for liquidity in these trading strategies.

4.69 This focus upon hyperactive trading may seem excessive, but it is has an important effect on the price discovery purpose of markets.. Whether or not high frequency traders use of liquidity is crowding out other potential uses, they potentially increase the 'noise' in market prices. If prices are to be informative to us, we need to be able to distinguish the signal from the noise.

4.70 Effectively to be able to do this at all requires that the signal is at least as large as the noise (for more details on the mathematics behind this, see for example Pierce JR, 1980). This is a well studied problem in information theory. For a more actuarial example, consider the much discussed question on the level of the equity risk premium. If equity prices returns relative to cash (the signal) showed no volatility (the noise), we could establish the equity risk premium precisely with a single observation (although in this particular thought experiment it is hard to justify any premium). If equity returns were say 3% pa above cash but volatility around that was +/-1% pa, then with say a decades observations we could distinguish the signal (3%) with a high degree of confidence despite the noise (+/-1% pa). As it is, even with over one century's observations of the UK equity markets, it is not possible to put more than a 1% to 2% range around an UK equity risk premium. This concept is illustrated by a simplified mathematical example below, as Figure 9, under the simplifying assumption that returns are normally distributed. The plotted surface represents the number of observations at which at which the information contained within the signal and noise are equal. It is evident that across most of the range of returns and volatilities that we observe in financial markets, it is not possible to distinguish the signal from the noise other than over very long time scales.

Figure 4.4: Signal equal to noise surface under normality



4.71 This analysis casts considerable doubt over the wisdom of solely using financial market prices as a basis for decisions, including in accounting statements.

4.72 This focus upon trading activity is relevant to liquidity inasmuch as it illustrates the possibility that a market (or economy) may have excessive liquidity. In this case, excessive short-term activity may obscure meaningful economic signals.

4.73 These results can be found in an experimental, laboratory context in a paper from Bloomfield, RJ *et al* (2006), or in a trading context in an empirical study, by Paul Tetlock (2007), of financial prediction markets where fundamentals are observable. The absence of observable fundamentals makes the empirical analysis of this proposition difficult in conventional securities cash or futures markets. Noise traders tend to congregate in highly-liquid stocks, while fundamental traders are active in illiquid stocks.

4.74 Many derivatives markets have been developed to facilitate the hedging of dealer inventories – for example, interest rate swaps or bond futures to hedge bond positions. This enables more transactions to be undertaken and higher gross volumes of inventory to be held by dealers. The hedges they provide are to changes in price – the net future price sensitivity of a bond and swap combined is lower than the unhedged bond.

4.75 As already noted, interest rate swaps and most derivatives are concerned with future liquidity, not current, which makes them =economically equivalent to insurance and clearly include substantial credit risks.

4.76 The extent of the potential future credit exposure was very substantial in the run-up to the 2008 financial crisis and substantially more than the net current credit exposures on which variation margin collateral requirements are based; this is discussed more fully and illustrated in Keating, C and Marshall, B (2010b).

4.77 Some short-term market activity by market insiders facilitates the execution of real economy exchange (e.g. the historic role of market makers), but it seems to the authors that there can be excessive volumes of short-term activity (some aspects of high freqeuency trading) to the detriment of real economy use of the market. This is a liquidity equivalent of the famous Laffer curve of tax effectiveness, trading off tax rates against tax receipts. This should come as no surprise as we know from banking markets that excessive liquidity is driven by, and drives excessive credit creation, and misallocations of capital – which usually end in tears.

5. Institutional liquidity management, instrumental liquidity and market microstructure

5.1 Institutions primarily need to be concerned with their liquidity at an organisational level, although fungibility of liquidity is as much as concern as fungibility of capital. Banks are well used to using liquidity ladder techniques to try to manage the term structure of liquidity of assets and deposits, although in the rapid escalation of reliance on short term funding in the run up to the crisis this seems to have been temporarily forgotten. For insurers, liquidity management is as much about working out when (and why) assets may need to be crystallised 'early' – this allows the cost of liquidity 'insurance' to be fairly judged against its benefits

5.2 Banks manage liquidity on both sides of their balance sheets, funding and asset market liquidity. As part of banks recent liquidity management has been the shedding of illiquid assets, we consider briefly how insurers and pension schemes might begin to assess the relative attractiveness of the potential yield pick-up from standing in banks' stead. For corporates the problem is more nuanced. We suggest that in all too many of the financial models actuaries commonly work with, the option or insurance value of liquidity is essentially ignored; ignoring material optionality from models in actuarial 'best estimate' of cashflows comes with many perils. There is more to corporate decision making than maximising NPVs! Perhaps also counter-intuitively, the liquidity of a market is not simply the sum of the instrumental liquidity (i.e. the liquidity of the assets on the markets); liquidity begets liquidity. We also introduce the concept of information insensitivity as being an essential characteristic of the liquidity of an asset; it means the asset will not change materially in monetary value over time.

5.3 In this chapter, we start in 5.1 by looking at bank funding risk, before moving on to briefly consider how institutions might take a more considered view of liquidity cost/benefit analysis than simply adopting a hurdle rate in 5.2. From there in 5.3 we consider a theoretical detour into the requirement for liquidity from a corporate viewpoint (closely following Holmström, B and Tirole, J, 2011). We then more on to consider instrumental liquidityin 5.4, including over time in 5.5. and then market microstructure in 5.5 before concluding by considering liquidity in both the short- and long-term in 5.7.

5.1 Bank funding risk

5.4 In 2009, the Financial Stability Forum (now Board) called for a "*joint research program to measure funding and liquidity risk attached to maturity transformation, enabling the pricing of liquidity risk in the financial system.*" It is not obvious to the authors that this has progressed very far though much work has been undertaken.

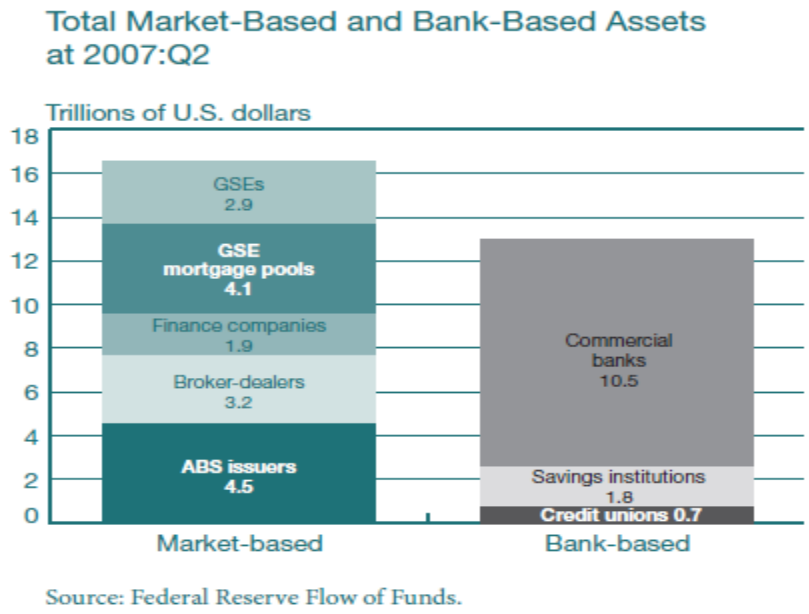
5.5 The relation between funding liquidity and market liquidity may be considered in terms of the side of the balance sheet to which these apply. Market liquidity is concerned with the asset side, and discussed and illustrated extensively in this paper. Funding liquidity, by contrast, is concerned with the liability side. 'Soft' factors such as reputation and governance of the institution can be important here and motivate the discussions of trust and confidence in section 2.4. Though it can be an important tool in distressed conditions, we do not discuss liability renegotiation in this paper.

5.6 The funding risk of a financial institution depends on both its liquidity position and its risk management policies, since these serve to limit the consequences of exogenous events. Sometimes returns are unaffected by market price movements, as for example in the case of the bond or loan bought and held to maturity. More usually banks use hedging instruments such as interest rate swaps to reduce the impact of market price movements on a mark-to-market balance sheet. Accounting policies and practices can also be important here, and should be considered as part of any risk management policy.

5.7 Some business strategies may simultaneously involve both sides of the balance sheet. For example, 'originate to distribute' or securitization may involve both the sale of assets and the creation of a contingent liability in the form of back-up lines of credit to the securitization vehicle.

5.8 It is worth comparing credit creation and maturity transformation in both the banking sector and markets. We illustrate below (Figure 5.1) the relative magnitudes of these for the US market immediately prior to the crash, at which point in time markets were actually larger than the banking sector. In less mature economies, it is usual for the banking sector, rather than capital markets, to dominate credit creation and maturity transformation.

Figure 5.1: Relative size of banks and financial markets (US, Federal Reserve Flow of Funds)



Source: Federal Reserve Flow of Funds.

5.9 It is also notable how significant US government sponsored enterprises (GSE) had become prior to the crash in terms of their capital market participation. Maturity transformation by these entities alone in capital markets exceeded fifty percent of the banking system. Though not shown in this figure, the duration of this transformation was also much longer than that undertaken by banks.

5.2 Liquidity for pension schemes and insurers

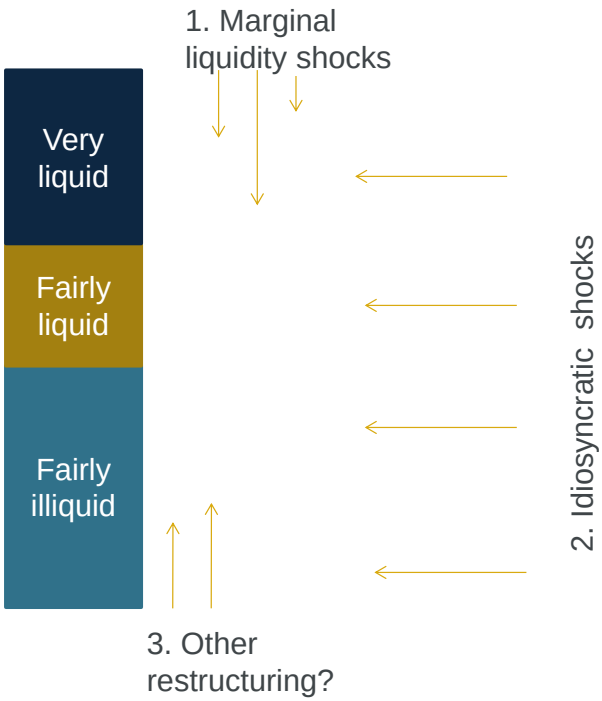
5.10 Defined benefit pension schemes and insurers are often considered to have excess liquidity, i.e. assets are more liquid than liabilities such that the probability that there is insufficient cash to meet immediate obligations is very low. Liquidity policy in this context is usually around demonstrating this holds over periods of time (e.g. one day, one week, one month) and under certain stresses to markets which may give rise to collateral requirements (which can be substantial for schemes which use invest significantly in derivatives).

5.11 On this basis, it is argued that pensions and insurance are natural homes for illiquid assets, particularly in an environment where there is less appetite in banks for such assets. However, traditional asset allocation studies historically have placed little emphasis on liquidity. Currently, there is a vogue for insurers and pension funds to acquire illiquid assets. However, with the result of the active central bank interventions pushing down risk free rates and many investors 'searching for yield' in illiquid assets amongst other places, future changes in the market price of liquidity could be substantial.

5.12 The insurance provided by liquidity has a cost to an investor. However, if presented with the choice between two assets of differing liquidity and yields, how does an institution choose? In other words, what value should be placed on the insurance, relative to its cost? We believe it must place its own value on the liquidity options that are embedded in assets by considering the circumstances it may be forced or want to sell assets before expiry. This value could be expressed as a haircut to yield in order to compare assets of differing liquidity. Importantly, the value of liquidity in a particular asset will depend on the overall liquidity of its entire

portfolio, as well as the liquidity requirements to meet its obligations; i.e. we need an enterprise wide approach to liquidity risk management. This is illustrated in figure 5.2 below.

Figure 5.2: institutional liquidity



Asset sales and costs incurred due to:

1. **Marginal liquidity shocks:** Most liquid assets to be sold first. Eg, liquidating assets to meet collateral requirements on derivatives positions.
2. **Idiosyncratic shocks**: Eg, Pension scheme liquidating all assets in the event of sponsor insolvency to meet buyout premium.
3. **Other:** Any other form of asset allocation change could lead to illiquid asset sales, eg due to changed relative attractiveness of assets classes, regulation, etc

5.13 Whilst a pension scheme or insurer may be comfortable there is excess liquidity in terms of withstanding shocks and meeting liability benefits, all other motivations for asset sales should be considered in evaluating the liquidity option. This should include:

- Increased capital required against an illiquid asset that is downgraded and cannot be sold.
- Opportunity cost of holding more liquid assets to take advantage of future market dislocations and regulatory changes.
- Costs incurred upon asset sales for any other reason.

5.14 A simplified example might be a pension scheme whose sponsor may have a 2% probability of default per annum. Upon default, all illiquid assets are to be sold to fund an insured buyout, and total costs of selling illiquid asset in terms of bid/offer may be 10%. Then this scheme may require additional yield to compensate for this risk of 2%*10% = 20bps per annum, on a best estimate basis. A more sophisticated model might take into account dependencies between defaults and the costs of realising illiquid assets, amongst other things.

5.15 In evaluating the likelihood of forced sales in the future, institutions may examine the extent to which asset cash-flows match liability cash-flows. However, this should examine actual net cash-flows and so is different from analysis of interest rate matching, as interest rate swaps would be expected to provide little net cash-flows to meet liability payments. In other words, much hedging is of the mark-to-market balance sheet position; genuine cash-flow matching would be seeking to match actual cash in- and out-flows. The analysis here is known as *dedication* and contrasts with the *immunisation* of interest rate sensitivity hedging analysis.

5.3 Liquidity for corporates

5.16 A naïve view of corporate finance would suggest that companies undertake all projects with a positive net present value (NPV). This ignores the credit constraints that have bitten so painfully in recent years. Even taking things to the next level and applying a credit constraint would imply you rank projects by NPV per unit

capital and maximise the company's NPV of projects subject to the capital constraint, or in other words consumption only depends on wealth. However, this still ignores uncertainty of outcomes and the (uncertain) profile of a company's liquidity needs over time. If you ignore uncertainty then insurance makes little sense; but as actuaries have learnt the hard way, the value of options should not be underestimated.

5.17 Holmström, B and Tirole, J, (2011) have looked at a range of economic models to bring out some of the key features of liquidity rationing that are not captured by simple NPV analysis of corporate finance decisions. The key ingredient they add is that a firm's income is not entirely pledgable to investors. In other words, some of a firm's income is illiquid. There are various reasons why this would be the case in the real world, but agency costs are a key one. Managers and employees will take a share in any corporate surplus, and importantly this share cannot be paid for up front (in a way that can be implemented).

5.18 This limit to liquidity limits wealth, and also limits the opportunity to increase wealth due to credit rationing, even if there are constant returns to scale from investments. It also creates a demand for a store of value both over time and across different states of nature, the role of money described back in section 2.1. In their model firms face credit rationing at the start and during projects. The key difference between an initial credit constraint and a future one is that firms can hedge future liquidity needs (at least in complete markets).

5.19 Liquidity is an alternative dimension to value, but is less well explored in corporate finance as well as in actuarial modelling. However, the "cash is king" adage holds in the real world. If a firm is profitable, liquidity is often less of a problem, but solvency concerns can lead to liquidity issues and lack of liquidity can cause insolvency.

5.20 Firms would tend to demand liquidity now, because they think it is cheaper today or as insurance as it may not be available tomorrow. This liquidity could come from the asset or liability side of their balance sheet, e.g. holding liquid assets, raising equity, putting credit lines in place,…

An introductory model: discrete investment choices

5.21 Consider a firm run by a risk neutral entrepreneur, who faces an investment opportunity with initial costs I with payoff $Z_1 > I$ (i.e. positive NPV), of which only $Z_0 < I$ is pledgable to outside investors (i.e. the project is not self-financing). This means that $I - Z_0$ needs to be paid by the entrepreneur or financed by the firm's existing assets.

5.22 The project will go ahead if the entrepreneur has access to assets $A \geq I - Z_0 > 0$.

5.23 All projects will go ahead if $A \geq Z_1 - Z_0$ (a trivial case), otherwise there is credit rationing.

5.24 Building on this model to look at some of the incentives facing the entrepreneur we find that factors that influence the total wealth created by a firm are:

- Less risky projects with lower expected returns increase pledgable income, which is more attractive when credit is rationed for the firm.
- Diversification can increase pledgable income, essentially by lowering the risk of a suite of projects.
- Intermediation (e.g. loan covenants and other monitoring) can increase pledgeable income by lowering agency costs.

None of these (common-sense, real world) conclusions can be drawn by merely looking through the world from an NPV lens.

A modestly more complex model: cContinuous investment choices

5.25 Let us take a slightly more complex model to follow, and consider how firms might choose to split their assets between current investments and hoarding liquidity as an insurance against future needs.

5.26 Let r_1 be the expected return and r_0 the pledgable income per unit invested in a project. Again, the scale of investment is I.

5.27 The firm has assets $A > 0$, and per unit of investment r_0 is raised from outside investors, while $1 - r_0$ is covered by its own funds.

5.28 $A \geq (1 - r_0)I$ is a budget constraint limiting the overall scale of the investment (credit rationing), which we can transform to see $I = A/(1 - r_0)$ is the maximum scale of investment. If the entrepreneur chooses this maximum investment scale their net return is $U = A(r_1 - 1)\ /(1 - r_0)$.

5.29 Following this through, wWe find that the entrepreneur will invest totally in the illiquid portion of the investment (which has greater return, by assumption), while the investors will only hold the liquid portion (by design). Interestingly, the entrepreneur does not maximise the expected return to maximise utility, rather they maximise the ratio $(r_1 - 1)\ /(1 - r_0)$. So they might sacrifice an increase in NPV per unit of investment for an increase in pledgable income.

5.30 In theory, if there could be a greater transfer of wealth from investors at time zero that would increase the overall output in the system. But within the model constraints there is no way (due to the lack of liquidity of the firm's income) to guarantee the investors any better return, and thus no way to incentivise this transfer of wealth.

Adding a further layer to the model: a liquidity shock

5.31 Let us now consider a three time period model, $t = 0,1,2$. At time 1 a liquidity shock occurs with value $r = r_H$ or r_L (H for high shock, L for low shock), and probabilities f_H and f_L respectively. Given a liquidity shock r, the firm can choose to continue production at rate $i(r) \leq I$. In other words, r is the additional cost per unit of investment. So the firm requires I at time zero, plus $ri(r)$ at time 1 and returns $(r_1 - r_0)$ to the entrepreneur and $r_0 i(r)$ to the investors. $I - i(r)$ is discarded and returns nothing (i.e. if investment is scaled back due to the liquidity costs, the investment that is scaled back is a sunk cost).

5.32 To get interesting behaviour we consider $0 \leq r_L < r_0 < r_H < r_1$.

5.33 In the low liquidity shock state, we have more than enough liquidity to continue investment at rate I, so there are no sunk costs. In the high liquidity shock state, we may or may not have enough.

5.34 We find that the project continues in the high liquidity shock state if and only if $r_H < c$. We can interpret c as the unit cost of investment, while r_H is the cost of liquidity. c is given by:

$$c = \min\{1 + f_L r_L + f_H r_H, (1 + f_L\, r_L)/f_L\}$$

5.35 We can rearrange to find that the firm will continue in both the low and the high state if and only if $f_L(r_H - r_L) \leq 1$. The intuition is that:

- If r_H is lower the liquidity cost in the high state is lower.
- If r_L is lower there are greater returns to scale from the initial investment.
- If f_L is lower, the likelihood of the low state is lower and the NPV of only continuing in the low state is lower.

5.36 This all assumes that the entrepreneur does what investors want, and has no other options. In practice, one of the key reasons for illiquidity in the first place is agency costs. For instance:

- It might be more desirable for investors if the firm maximises initial investment but can only afford to continue in the low liquidity shock state. However, the entrepreneur might hedge their bets so that at time 1 they can continue even in the high shock state, but at a lower level of overall production.
- It might be more desirable for investors if the firm does not maximise initial investment but keeps assets back to 'self-insure' against a high liquidity shock. However, the entrepreneur might maximise the initial investment anyway in hope of a low liquidity shock.

5.37 Either way at time 1 the entrepreneur leaves the investors with a fait accompli. If continued production is affordable the firm will do so, and if not it has no liquid assets left to raise more funds.

5.38 While the models set out in this section are simple, they provide some results that are intuitive and reflect actual business practice more closely than NPV models which ignore liquidity. They also start to explain the substantial efforts corporations undertake to manage their treasury functions, and even justify the existence of conglomerates. Firms are not just able to diversify returns (which investors can in theory do themselves), they provide inside liquidity to different parts of the business in a more cost effective manner (due to agency costs) than can otherwise be done.

5.4 Instrumental liquidity

5.39 We have defined asset, or instrumental liquidity as the ease of exchanging it for money, rather than the ease of financing it. This latter definition is favoured by many banking supervisors. Of course, the two concepts are closely related. This description of instrumental liquidity as its value in transaction use is a money stock rather than flow concept. Of Crockett's facets to liquidity set out in paragraph 3.16: depth, immediacy and tightness are related to the stock aspect and resilience to the flow.

5.40 The liquidity of a market is not usually the simple sum of the liquidity of the individual instruments present. This relates to the discussion of market fragmentation in paragraph 4.16 and the widely held belief that liquidity attracts liquidity. Arbitrage and other activities can greatly influence the aggregation (or not) of liquidity in markets, and its availability at an instrument level, particularly when trading is fragmented across numerous venues.

5.41 The property that makes an instrument a good store, or hoard, of liquidity is that it should be information insensitive. In practical terms, this means that the instrument should typically be of very high quality and be short-term in nature, for example a Treasury bill. Money is, ideally, entirely insensitive to information, even though it may have failings as a store of real value.

5.42 For brevity, we will avoid reviewing the information theoretic literature beyond noting that the cost of information acquisition prior to transacting exceed the gain. So the effort to be expended on information acquisition should be proportional to the potential gain; we research high yield bonds, but not the credit status of the US treasury. The credit ratings provided by agencies are important in this regard as indicators of where to commit scarce and costly analytic resources. The AAA ratings on mortgage securities, which proved so catastrophically wrong, had the pernicious effect of directing research efforts away from them.

5.43 As with money, to be liquid, or exchange freely one for another, securities need to be fungible; the homogenous property in Jevons' taxonomy set out in 2.11. The property here is that one instrument should be indistinguishable from another[37], and with that, there should also be no distinction based on the identity of participant in exchanges. One of the attractions of bearer bonds was precisely this form of anonymity.

[37] The concept of fungibility could be used to frame a more general theory of liquidity. In other words, the more fungible items are perceived to be, and this is very much a cultural construct that changes over time, then the more liquid they become.

5.44 Even seemingly innocuous differences can be important – for example: in the 1970s, Amax issued two bearer bonds with identical terms – one tranche of $25 million and another of $15 million – they differed only in the colour of the ink on the certificates, red and blue. However, the red bonds were not fungible with the blue, and red were not acceptable in discharge of the sinking fund obligations of the blue, or vice versa. The result was that these bonds could trade as much as ten percentage points apart when the sinking fund was operating[38].

5.45 Simplicity in instrument design improves liquidity as little verification is needed. Vanilla bullet issues are preferred to sinking fund debentures – complexity is inimical to liquidity. Similarly, greater size of issue enhances liquidity as it makes securities easier for dealers to find and buy or borrow, which tends to improve bid-offer spreads – i.e. increase tightness.

5.46 This brings into question the motivation of banks in bundling together simple products to offer complex instruments, which are not simple to analyse or value, let alone easily transferable.

5.47 The complex cash flows of amortising bonds, with call features and sinking funds, which characterised the sterling corporate bond market of the 1960s and 1970s required much analysis to establish their value. This period also saw bond issues convertible to gold under various terms and even bonds that paid coupons in railway travel warrants. Such complex securities can be extremely attractive to long-term investors possessing analytic skills, and no need for interim liquidity. These securities were to a very large extent bought and held by institutional investors and indeed could usually be readily sold even though there was no active market in them. There is an argument, from the perspective of an investor, for defining liquidity solely in terms of the ability to sell a security; as we shall see later, active two-way markets do not exist for most bonds.

5.48 Securities that are accepted in open market operations and other central bank operations tend to be liquid because of their value to banks in this context. We will discuss banking liquidity regulation in section 7. Securities, which are accepted in repo subject only to low and stable haircuts, draw their liquidity from the wide audience of short-term investors seeking yield enhancement above government securities.

5.5 Instrumental liquidity: time and curves

5.49 One key property of liquid securities is that information asymmetries between seller and buyer, which include the obligor at issuance, are small and not subject to great change. The AAA rated tranches of mortgage backed securitisations were a complete failure in this regard – they proved to be hyper-sensitive to information as the US housing boom turned to bust. In the absence of this information insensitivity, the liquidity of an instrument may be highly time variant and profoundly asymmetric.

5.50 It is notable that government bond markets exhibit a phenomenon known as ‘on-the-run/off-the-run’ spread where securities that differ in little other than their time since issuance, and perhaps issue size, trade at different prices and yields. It is usual practice to construct yield curves from the lower yielding more actively traded ‘on the run’ issues, which are often referred to as “benchmark” securities. These on the run issues also tend to have tight bid-offer spreads and larger normal trade size quotations, demonstrating the cost of additional liquidity.

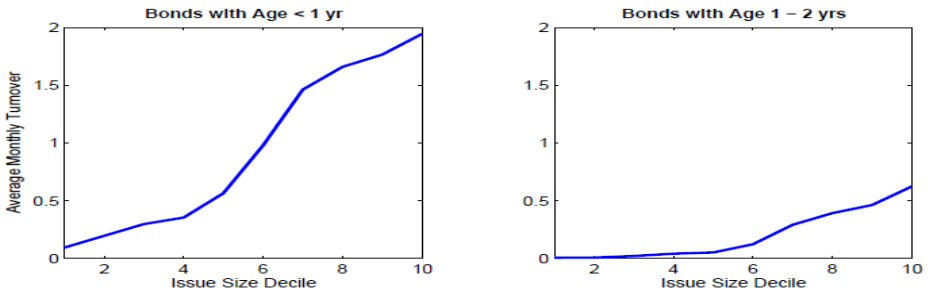
5.51 Older issues are often described as ‘seasoned’, meaning that the majority of the securities have found homes and purposes in investment institutions from which it may be difficult to dislodge them, to acquire or even borrow them. In consequence, in addition to the yield differential the bid to offer spreads of these issues may be wider than on benchmarks. These issues have a lower “free float” of securities readily available for trading. This concept is an illustration of the value of a security as part of the money stock. The dispersion of

[38] There are numerous other examples, such as dual-listed firms - their stock often trade at different values in these different venues; hence they are not exactly fungible.

the ‘off-the-run’ to ‘on-the-run’ issue yields (or the dispersion of actual yields around the benchmark yield curve) is another more advanced measure of government bond market liquidity.

5.52 Figure 5.3 below shows the monthly turnover for bonds in the US credit markets aged less than 1 year, owned by insurers, as a function of issue size decile. This is repeated on right hand side for bonds aged 1 -2 years. The seasoning issue described above is notable by comparing the left and right charts. Turnover improves with larger issue sizes as these issuers are more prominent, often of higher credit standing, and market makers are more likely to be able to match the buyers and sellers in trades.

Figure 5.3: Relation between Issue Size and Turnover



Source: Hotchkiss, E and Jostova, G (2007)

5.53 Many debt management offices go to considerable length to issue securities that have benchmark status. They seek to exploit the phenomenon that larger issues command higher prices. This is a challenge for more common rules of supply and demand where lower prices for a good are usually expected in response to greater supply.

5.54 Some debt management offices explicitly reopen issues to increase their outstanding size and with that market liquidity, which, in this context is typically measured as trading volume. The benefits that market insiders perceive of larger issues, and for which they pay a liquidity premium is that these securities will command tight bid-offer spreads and trade in larger than usual size.

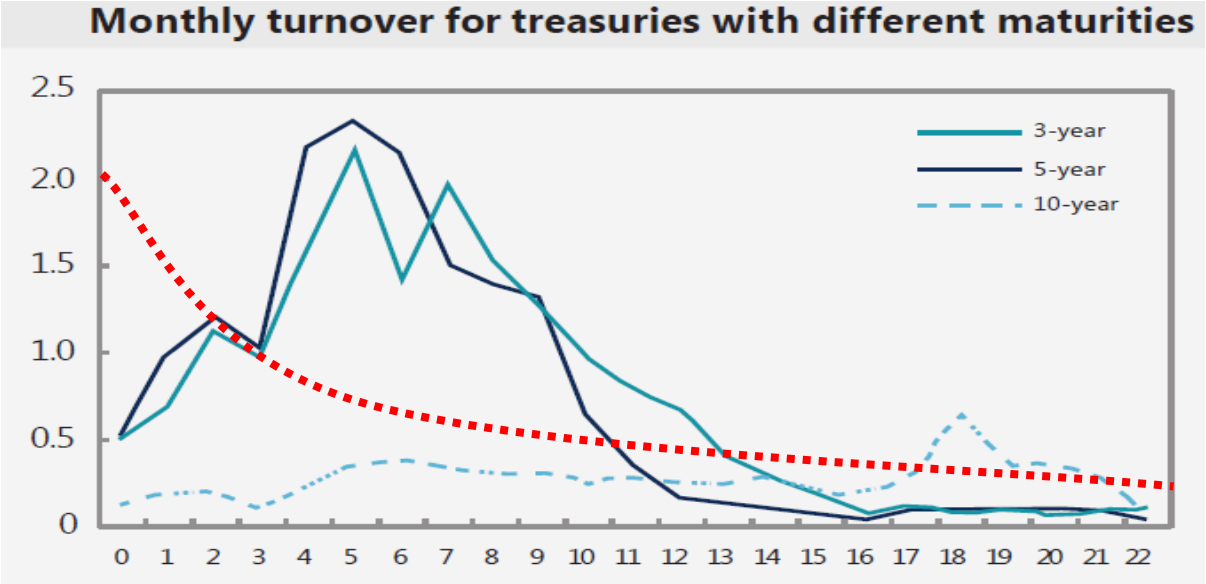
5.55 This is extremely useful and valuable to dealers who have acquired short positions in the ordinary course of their market-making activities. It is also useful to investors who need to rely upon future liquidity to realise the sale of a security to crystallise a particular performance.

5.56 In bond markets, the liquidity (in the sense of trading turnover) of a security is usually an exponentially declining function of the time since issuance. This is illustrated indicatively below (Figure 5.2) as the red dotted line, together with the comparable monthly trading turnover figures for Korean government securities of varying maturities.

5.57 The pronounced peaks in trading activity, in the four to six month period, evident in Figure 5.4, arise from the practice in the Korean government bond market of reopening issues. One interpretation of this is that it increases the time necessary for a bond to have seasoned and found firm investor ownership.

5.58 There appears little difference between the three and five year issues, but turnover in the long bond, the ten-year issue, is low. This implies that the issues have found firm investor ownership. The relative trading levels at times beyond 12-15 months are to be expected given the relative volatilities of these securities. The increase in the ten-year trading activity at the eighteen-month time was the result of a new ten-year bond being introduced – the old ten year being sold and the proceeds reinvested in the new.

Figure 5.4: Bond turnover and time since issuance (Korean Governments) – proportion of issue size.



5.59 The lower volume of trading activity in long dated fixed income securities exhibited here is by no means universal. The level of activity is very closely related to the extent of actively trading participants in a market. Long bonds are usually the most volatile in a market and as such ideally suited for active trading. Albert Wojnilower (as quoted in Karman, S, 1991), stated that the average holding period of U.S. Treasury bonds with maturities of ten years or more was only 20 days in the late 1980s.

5.60 Finally, no discussion of the liquidity of an asset would be complete without discussion of the counterpart liability. Some financial contracts may be either assets or liabilities depending upon the state of the world at the time of valuation – an interest rate swap is a prime example.

5.5 Market microstructure and liquidity

5.61 The design of market microstructurecan also influence the costs of issuance. These arrangements can include the form of issuance, such as underwritten syndication versus open market auction, with primary dealers having responsibilities that may vary significantly from country to country. Tap issuance can also markedly affect secondary market trading activity. Even the form of auction order matching, such as from uniform price allocation to discriminatory submitted bid price allocation, can influence the issuance cost.

5.62 It was notable that in the wake of the crisis many debt management offices reverted to the use of syndication rather than public auction for some types of issuance, such as ultra-long securities. Some debt managers have begun using security designs that they had not previously used; the US use of floating rate notes and the Irish issuance of annuity bonds are examples.

5.63 Issuance discount costs tend to be largest when there is high uncertainty among dealers and investors. When-issued markets can go far in resolving uncertainty over demand and price, lowering these costs.

5.64 It is possible to examine the development of turnover profiles of particular market instruments over time. However, there is a problem of interpretation: does increased turnover really mean increased liquidity in any economically meaningful sense. It may be that the variation in activity is entirely the result of intra-dealer activity, with no change in non-dealer positions. It is also possible that turnover statistics for instance mask a relatively stable set of long-term institutional holdings with a small free float that is frenetically traded.

Notwithstanding these caveats, popular usage refers to securities and markets with high turnover as being highly liquid.

5.65 This does throw light on the much-discussed question of the risk-free rate of financial theory and many valuation techniques. The use of the on-the-run curve to derive "risk-free" rates is biased towards lower yields as it utilises the most actively traded securities. Indeed, the question goes beyond this as the risk-free rate is being derived from observable market prices, which contain a liquidity premium. It is the most actively traded, most liquid securities where this liquidity premium is highest at any point in time.

5.66 Put another way, actively traded securities are those that are most likely to be priced based on expectation of future sale price rather than for the cash flows they provide over the long term. Illiquid securities tend to be purchased by investors who will hold them over the longer term who are prepared to conduct the necessary and costly research and analysis to inform themselves as to the merits of these securities.

5.67 Notwithstanding this relation, many investors in illiquid markets do underwrite and price assets by reference to the spreads and ratings available in liquid credit markets.

5.68 The conceptual risk-free rate is a pure time preference rate; it is time preference for liquidity. It follows from this that low government bond yields may be telling us more about expectations of liquidity at future times than about the investment returns we may achieve in any particular time span on other asset classes whose expected returns are modelled as risk-free plus (some) risk premia.

5.69 If you grant credit (or indeed make almost any investment) it is because you expect future liquidity, i.e. ultimately to receive money in future from those you grant credit to. As it is future liquidity, both the possibility of default and potential levels of inflation become relevant concerns. The range of insolvency likelihoods for AAA rated securities is measured in a few basis points, while low quality securities may have likelihoods of insolvency measured in many percentage points. Lower quality securities are much more information sensitive and their current liquidity is usually low and highly variable as a result.

5.70 Yield curves that allow for credit effects may slope downwards with maturity rather than have the usual positive slope of pure time preference. A multiplicity of yield curve shapes at different levels of credit quality may arise due to these dependencies. Even at quite high quality securities (e.g. AA) the spread around any particular curve is of a different order of magnitude to the spread around a typical gilt curve and so the term 'yield curve' means something rather different..

5.71 It is sometimes argued that the haircuts applied in the repo market (or equivalently the initial margin in a Futures Exchange or Clearing House) are a measure of the short-term volatility of the relevant securities. However, it should also be recognised that the regulatory treatment for capital adequacy purposes materially affects the haircuts observed. The haircut is a form of over-collateralisation that in the event of default is intended to provide the dealer with a good chance of liquidating the position at no loss. This process takes place outside of the automatic stay feature of most bankruptcy systems. Any surplus arising from the liquidation would belong to the administrator of the defaulted.

5.7 Liquidity and the short and long-term

5.72 One approach to the analysis of the different securities and instruments issued by the corporate sector considers these in terms of their time priority. Commercial paper might have a time priority of 30 days, while bonds might have a tenor of ten years, and equity represent the residual claim beyond the discharge of all dated claims. This is a counterpart to the corporate treasurer's view, which is concerned with management of the asynchronicity of receipts and disbursements of cash.

5.73 It is possible for the duration of debt claims to exceed the duration of the equity claim. This can be illustrated by considering an equity that pays a constant 10% dividend with a nominal reduction in the dividend expected of 3.5% pa (i.e. growth in the underlying equity of 6.5% p.a.) and a 30-year bond paying 7% pa - at a 5% pa discount rate, the duration of equity is approximately 12 years and the duration of the debt nearly 15 years. When considering the sustainability of an investment over its term, it is appropriate to consider the current position of the company in the life cycle of that company.

5.74 Bankruptcy disrupts the normal ongoing operation of liquidity in a company; it stays all payments, breaking time priority. In liquidation, a form of acceleration of claims, all creditors within a class are paid simultaneously, following class priority.

5.75 One way of defining whether investors are holding instruments for either the short or the long-term is by looking to the source of ultimate liquidity. When they are relying solely on the performance of the contract, the source of liquidity is the obligor, and we may consider this long-term. By contrast, reliance upon the market for ultimate liquidity is short-term. Many holding periods, or investors, are somewhere between these two extremes as some of the liquidity will come from payments due on the instrument but it will not be held to expiry/in perpetuity. There are echoes of this proposed definition in earlier economic work; Alfred Marshall considered the short-term to be the situation of working with a given endowment of fixed capital and the long-term to be concerned with variation of fixed capital resources.

5.76 The majority of corporate liabilities are not negotiable – in many cases, they are incomplete contracts and transactions on them arise only due to the ability of the corporate to exhibit commitment, i.e. to be creditworthy. Nowhere is this truer than of long-term insurance and pension liabilities.

5.77 In the case of a tradable security issued by a corporate, the liquidity option of a market price does not rely directly on any performance by the obligor – it relies upon market liquidity and there is no recourse to the sponsor. Typically, the issuer will have incurred costs at issuance and have ongoing costs with respect to disclosure and servicing but there is no explicit requirement to fund the liquidity of the security (beyond coupon payments, or to a lesser extent, given their discretionary nature, dividends).

5.78 At issuance, the market price to an investor is higher than the cost to the obligor. Indeed, this relation is to be expected to persist unless liquidity is unconstrained. The issuer can always buy back securities that trade below their cost to the obligor. In the early 1980s, this was not an uncommon practice; there was much activity in the defeasance of bonds that were trading at steep discounts to their nominal face value. It is also evident in the repurchases of debt by both Barclays and Lloyds in the aftermath of the crisis; in these cases, it was most likely further enhanced by the prior use of hedge accounting.

5.79 Defined benefit pension liabilities are by design not negotiable for cash (although, for example, I the UK scheme members have a right to a ‘cash equivalent’ of their benefit before retirement). There is no equivalent traded security, nor can there be. Valuing long-term liabilities on the basis of market prices or rates based on liquid securities introduces the liquidity premium of those traded securities into the valuation of the non-negotiable liability.

5.80 The problem for pension schemes is compound. The use of market prices for liabilities usually overstates them (depending on the purpose of the valuation and the market prices used of course), while the use of liquid assets as investments tends to depress their yields and returns. The only scenario, at least in the UK, where completely liquid assets might be warranted and liabilities are negotiated would be in the event of sponsor default as discussed in section 5.2. Otherwise, the use of solely liquid securities depresses returns in normal circumstances in order to provide for the rare tail event of sponsor default.

5.81 In fact the use of market prices for portfolio valuation is profoundly problematic inasmuch as all securities cannot possibly be realised at these marginal prices, even large portfolios cannot be realised without a price impact. This echoes again Keynes' point from 1.5 about lack of liquidity for the investment community as a whole.Another problem, at least in the UK, is the gradual effect of legislation and market practice 'guaranteeing' liabilities, which used to be discretionary, against a guaranteed (i.e. UK gilt) asset base that is too small to match those liabilities. This arguably has driven up the price of gilts very substanitally, and hence the price of the liabilities benchmarked against those gilts, although by how much depends on your choice of model for the price impact of pension fund and insurance company demand.

5.82 The issue of the long-term is further confounded by the nature of financial markets, which at short horizons are dominated by price concerns – that is to say inside active trading. This activity introduces volatility into prices which is usually absent from fundamentals, but reflects the sentiment of traders about the future prospects for those fundamentals, or the sentiment about the future prospects of sentiment on those fundamentals, or the sentiment about the sentiment about the sentiment (and so on).

5.83 The use of market prices is appropriate for the valuation of dealer trading books, and long-term liabilities should be valued on the basis of what the contract owner could claim at valuation date in an insolvency court proceeding.

5.84 This point is worth elaboration. Consider a company that has issued two different zero coupon bonds maturing at the same date, one issued at a redemption yield of five percent and another issued at a redemption yield of ten percent. On insolvency, creditors will have valid claims for the return of their principal and the accrued "coupon" to insolvency date. The claim on the ten percent issue will be (slightly) higher. It is interesting to note that secondary trading prices for such securities recognise and reflect such differences in claim value.

5.85 It is inappropriate in most circumstances for any company to value their own issuance on the basis that it is credit-impaired; the liability (and investor claim(s) over corporate liquidity) has not changed. However, this is exactly what we saw from many banks and dealers during the credit crisis. The use of mark to market valuation induces short-termism.

5.86 To argue the alternate view: from an equity holder perspective (who after all reporting is for), leveraging up increases the value of the limited liability put option creating value. However, accounting for this put option does not reflect the corporate position, it is an investor perspective. It does though highlight some limitations of current accounting and the single view that an ongoing basis provides, in an uncertain world.

5.87 Short term trading is not entirely harmful. The deployment of funds into instruments that are longer in term than the horizon at which those funds are expected to be required is a form of maturity transformation. It reduces to a degree the conflict between money as a means of payment and a store of value – a principal role of banking. In this regard, the securities market facilitates a maturity transformation function that is very similar to that of banking. There are close similarities between funding liquidity and funding risk in banking and this maturity transformation role of markets. The institutions in markets though are usually not recognised banks. Surprisingly, the economic value of maturity transformation has not been widely investigated in the empirical economics literature, and as a result it is presently impossible to quantify it.

5.88 It should be realised that if we cannot sell a security in a market, we cannot usually expect to be able to finance it by repo. In this situation the security's value as a store of liquidity can be severely impaired. Financial crises most often first manifest themselves as the inability to refinance a position held.

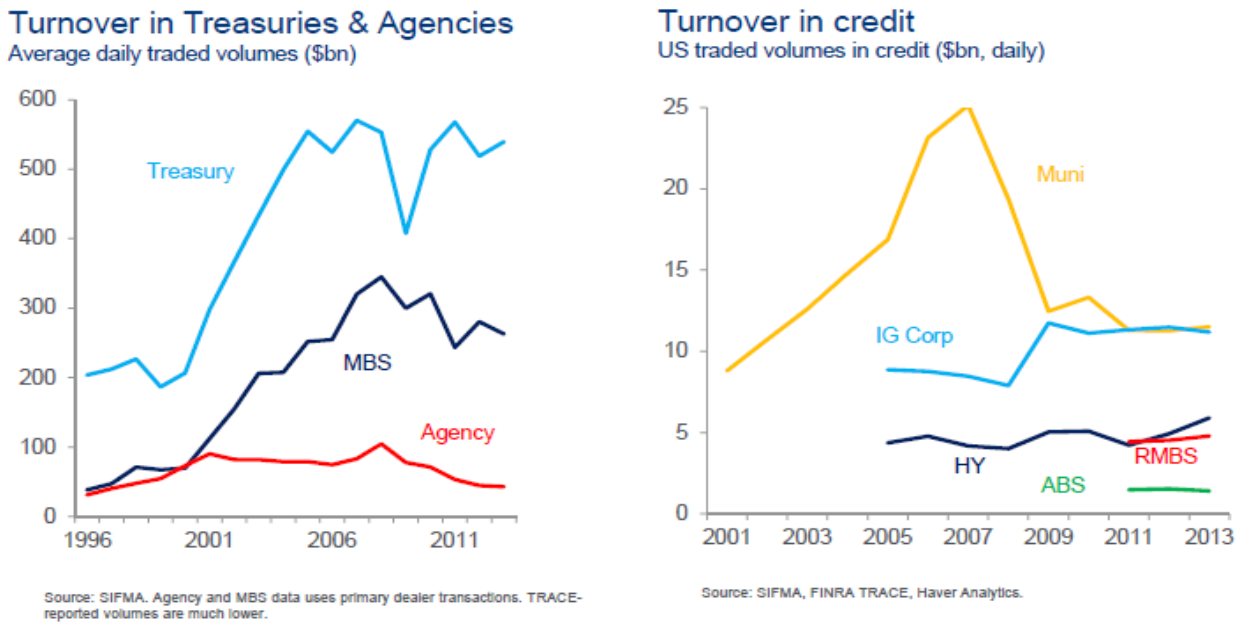
6. Market liquidity – a case study

6.1 In this section, we use the recent financial crisis to examine how liquidity has changed in recent times in a variety of, predominantly US, fixed income markets. In 6.1 we look at turnover volumens, in 6.2 transaction costs, in 6.3 US corporate bonds and in 6.4 US Treasury acutions, in 6.5 dealer positions before culminating in 6.6 with non-dealer positions. As noted earlier, the levels of secondary market turnover, even in highly developed markets, can vary markedly over time, as can be illustrated (Figure 6.1) for the US bond markets. These are daily turnover values in simple dollar amount traded terms.

6.1 Turnover volumes

6.2 The main conclusions we would draw from this section are summed up in the market aphorism that liquidity is usually fine until it is needed and to the observation that markets can foresee everything except the next crisis. Furthermore, the evidence shows that liquidity did not transmit itself instantaneously or frictionlessly across sectors of the financial markets. This was perhaps the essence of the systemic crisis.

Figure 6.1: Turnover volumes is US bond markets - USD (SIFMA, FINRA, TRACE, Haver Analytics)



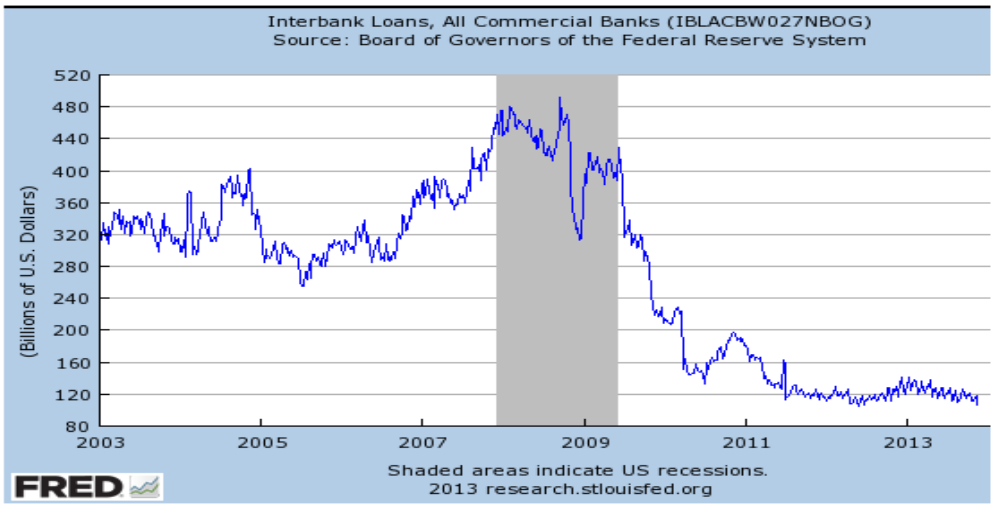
6.3 These turnover figures are perhaps surprising given the magnitude of the shocks experienced by markets in recent times. It is evident that transaction volumes have held up well in most market segments.

6.4 The collapse in activity in municipal securities was the most profound among bond markets. This was driven by at least two sector specific effects – the pre-crisis prevalence of auction (adjustable) rate municipal securities and the use of mono-line credit insurance. Prior to the crisis, credit enhancement by mono-line insurance was used by more than 50% of issuers, and is now less than 5%. Auction rate issuance has declined by almost 90% since 2007. In large part, these securities were predicated on the willingness of the sponsoring securities dealer to subscribe to them, i.e. supply liquidity, if they were undersubscribed at any auction rate reset. These contingent liabilities were not recognised in the dealers' accounting statements.

6.5 US bank lending rose markedly in the immediate aftermath of the Lehman failure. This was in large part because the corporate sector, with precautionary motivation, drew down their committed lines of credit.

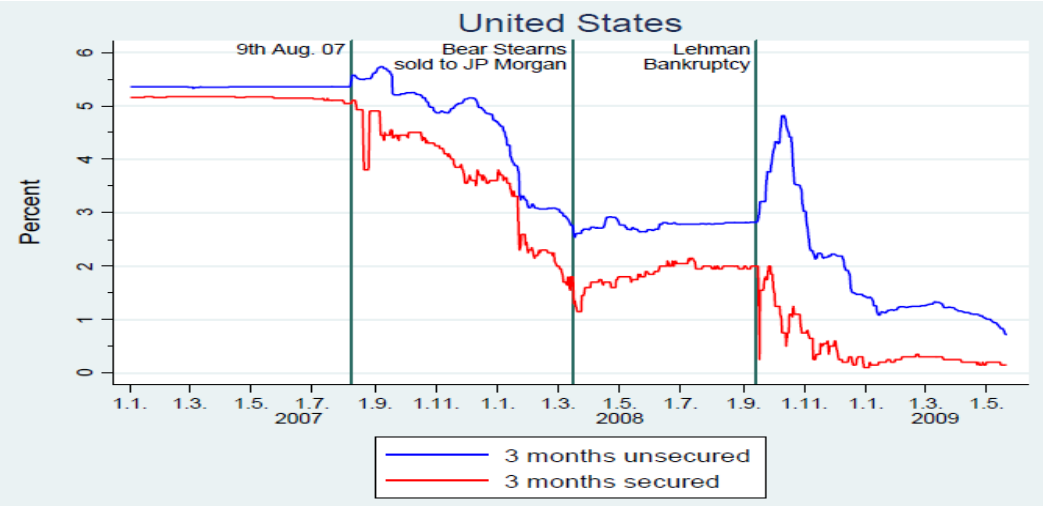
6.6 A startling measure of turnover was the decline in unsecured interbank lending, which is shown below (Figure 6.2). The timing of the start point for this decline is interesting as it occurs in late 2007. It is also notable that this market has not recovered. It is also evident, though not illustrated, that a very significant part of current activity (approx. 30%) is arbitrage of the Federal Home Loan Banks[41]. This decline in interbank activity was even more pronounced in the European money markets.

Figure 6.2: Unsecured Interbank Loans (Board of Governors of the Federal Reserve System.



6.7 This decline in activity cannot be explained by interest rate differentials. The crisis had the effect of separating the rates paid on unsecured deposits from repo rates (Figure 6.3).

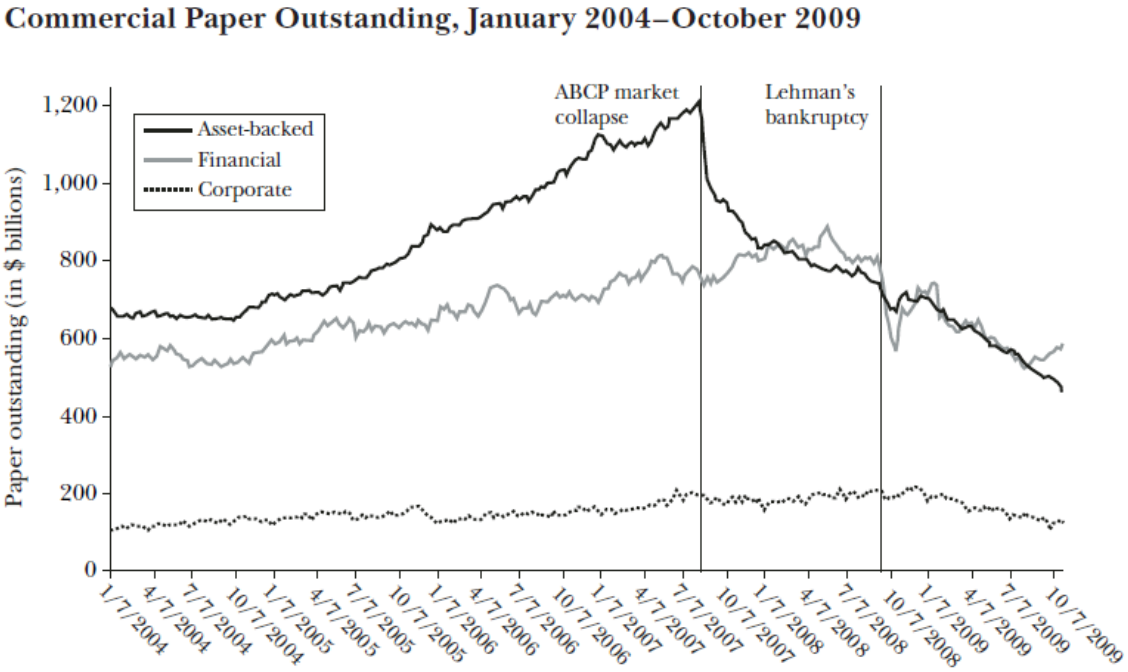
Figure 6.3: Repo and unsecured three month deposit rates



6.8 The abrupt decline of the Asset Backed Commercial Paper market began in August of 2007 (Figure 6.4). It is notable that commercial paper issued by financial institutions did not begin to decline for another year, until after the insolvency of Lehman.

41 Federal Home Loan Bank deposits at the Federal Reserve are not remunerated directly. Commercial banks may take depositions from the Federal Home Loan Bank paying it a rate of 5-10 basis points and redeposit these funds with the Federal Reserve earning 25 basis points.

Figure 6.4: Commercial Paper Outstanding (Kacperczyk, M and Schnabel, P 2010)



Source: Authors' analysis based on Federal Reserve Board data.
Note: Figure 1 shows the weekly commercial paper outstanding. The asset-backed commercial paper (ABCP) market collapse was August 9, 2007. Lehman's bankruptcy was September 15, 2008.

6.9 The figures in this subsection highlight the difficulty in putting a precise date on the start of the financial crisis. It is evident that liquidity did not transmit itself instantaneously or frictionlessly across sectors of the financial markets and that various sectors of the markets experienced liquidity shocks at different times. This was perhaps the essence of the systemic crisis.

6.2 Transaction costs

6.10 As we noted earlier, turnover is an incomplete measure of liquidity. When average yield spread differences between 'off- the-run' and 'on-the-run' US treasuries are compared, we can see that activity has adapted to an environment in which higher transaction costs are accepted. In other words, while government bond market turnover has held up, this has taken place in an environment where bond market trading liquidity as measured by the 'off the run' spread has a greater cost (Figure 6.5). So despite the decline in treasuries' yields which has occurred since the crisis broke, and the lower cost of central bank money to the banking system, the cost of trading has increased.

6.11 Bid-offer trading spreads can also be extremely volatile with a tendency to spike in response to news and activity. This is illustrated below (Figure 6.6) using two metrics: the cost to trade two thousand Treasury bond futures contracts and the (Roll) modelled bid offer spread for corporate bonds.

The Roll measure (Roll, R, 1984) of the implicit bid-offerspread is:

$$Spread = 2\sqrt{-Cov\ (Price\ changes)}$$

where Cov is the first order serial covariance of price changes.

Figure 6.5: Off the run spread versus traded volume US Treasuries (Haver Analytics)

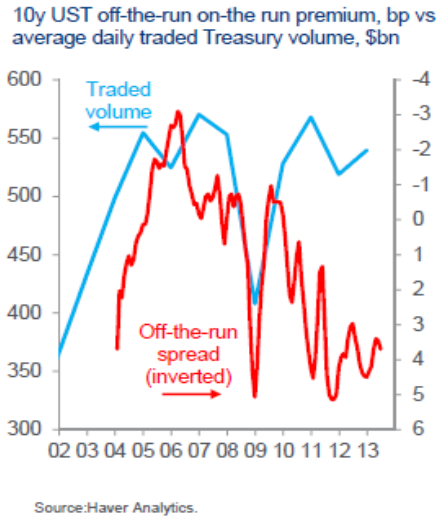
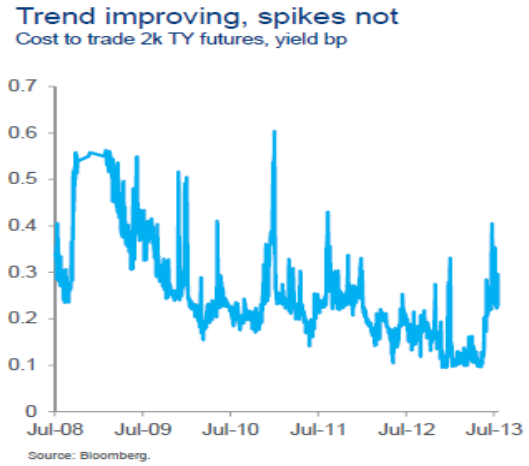


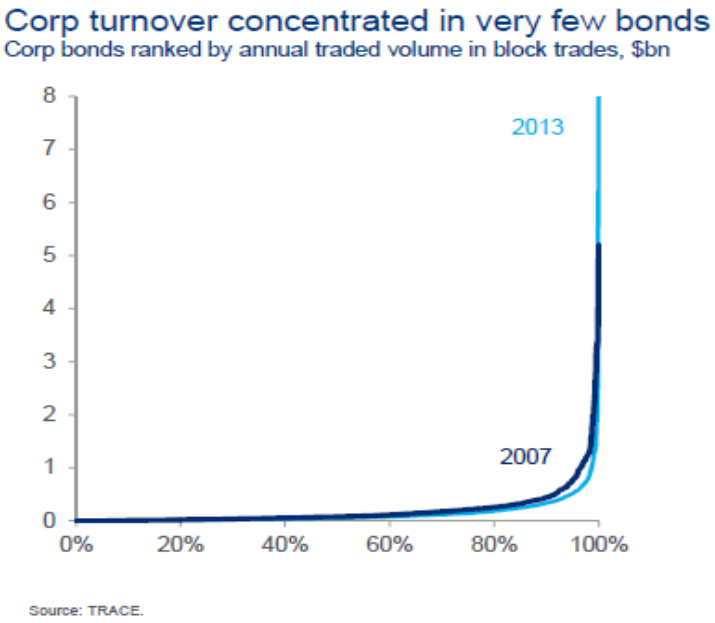
Figure 6.6: Measures of bid to offer trading spreads.



6.3 Corporate bonds

6.12 Most corporate bonds have never traded actively; activity is typically concentrated in a small number of bonds. Hotchkiss, E and Jostova, G (2007) find that issue size and age are the prime determinants of trading; a US $ 150 million increase in the size of an investment grade issue increases the likelihood of trading in a month from 35.7% to 55.5%. The concentration of trading is illustrated pre and post crisis in Figure 6.7. The crisis does seem to have resulted in even greater concentration in this regard.

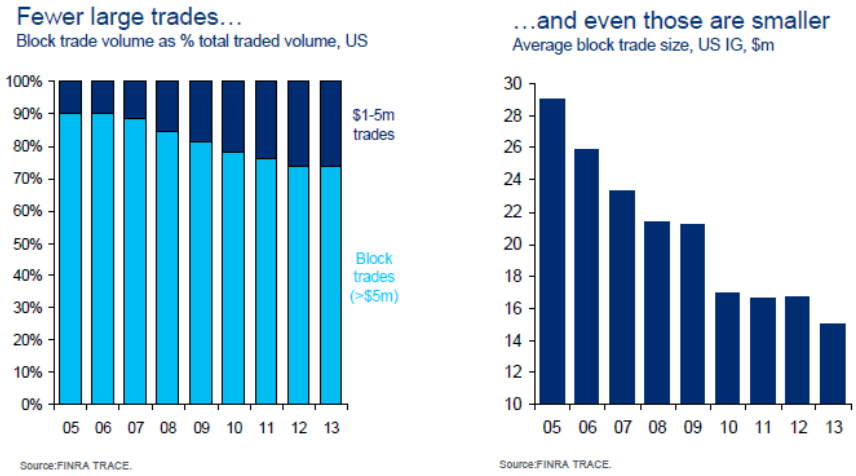
Figure 6.7: Corporate bond turnover concentration pre and post crisis (TRACE)



6.13 Though not illustrated here, the tendency for corporate bonds not to be traded also exhibits the same characteristics with respect to time since issuance and seasoning shown in section 5.4. At one point in time, international Eurobond securities, which were not eligible for sale in the US until after they were seasoned, would tend to show flurries of trading activity after this period had elapsed when they became available to US investors.

6.14 Corporate bond trades have been trending to smaller trade sizes, as is illustrated in Figure 6.8. By this depth measure, secondary market liquidity has declined materially.

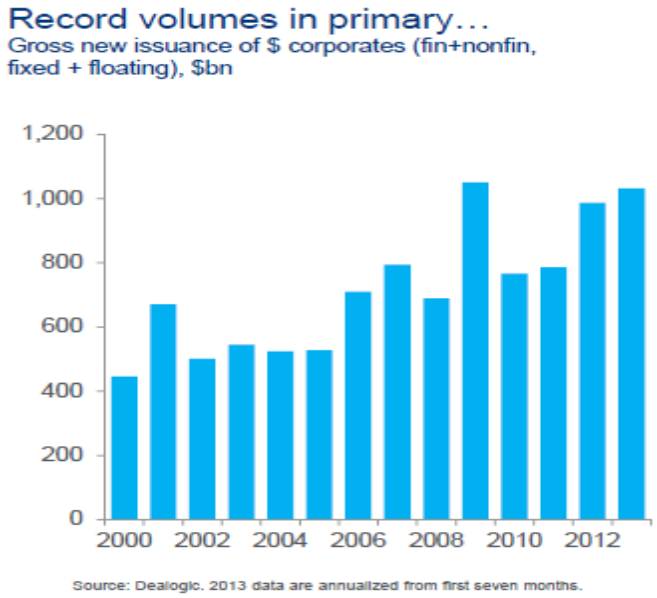
Figure 6.8: Trade sizes and shares (FINRA, TRACE)



6.15 Comparison of the trade sizes shown here with the order sizes shown in the earlier Figure 4.2 for the electronic platform Market Axess, makes it evident that the electronic platform attracts far smaller orders than are executed in other more traditional markets.

6.16 The question of the extent to which markets have been able to continue to fulfil their economic role of providing new finance for economic enterprise is not answered by considering secondary market turnover or these depth metrics. The relevant direct measure is the volume of new bond issues placed, and this has reached record new highs in the US, as is illustrated below in 6.9.

Figure 6.9: Primary Bond Issuance Volumes



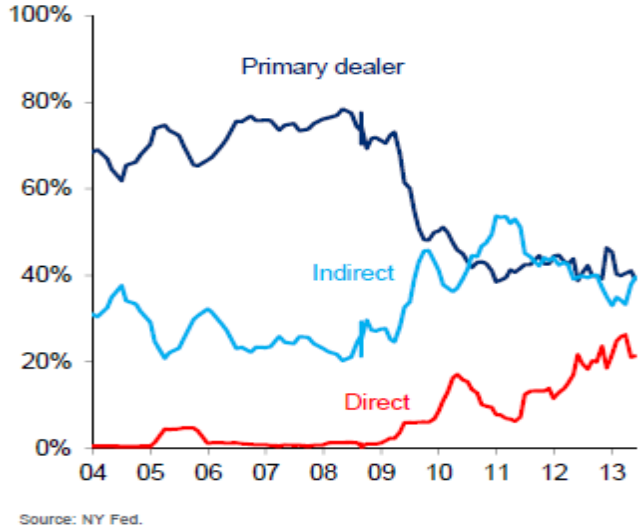
6.17 There are many possible non-exclusive explanations for the increase in new corporate bond issuance, from the low levels of interest rates to reduced availability of bank credit and even the effects of quantitative easing. However, by this measure, markets are performing their real economy role better in the post crisis period.

6.4 US Treasury auctions

6.18 Participation in primary US Treasury auctions has changed in the post crisis period (Figure 6.10). To quote from a Federal Reserve blog: "*On December 12, 2012, primary government securities dealers bought just 33 percent of the new ten-year Treasury notes sold at auction. This was one of the lowest shares on record and far below the 68 percent average for ten-year notes reported in this 2007 study by Fleming.*"

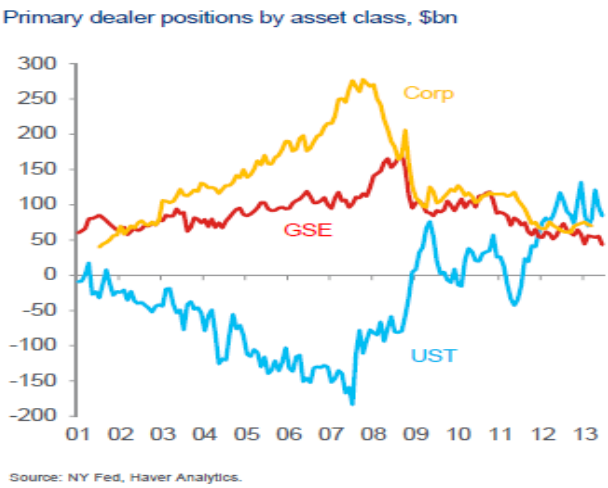
6.19 "*The decline in the share of primary dealer purchases at auction has been offset by increased purchases by other dealers and brokers (from 4 percent to 8 percent), investment funds (from 8 percent to 18 percent), and foreign and international investors (from 11 percent to 13 percent). Other investors, including depository institutions, pension funds, and individuals, have consistently accounted for about 3 percent to 6 percent of purchases over time.*"

Figure 6.10: Forms of participation in US Treasury auctions (New York Fed)



6.20 This is not a result of a changing ownership of US Treasuries – dealers have increased their ownership – Figure 6.11. In early summer 2007, dealers were in fact net short of slightly more than 5% of outstanding Treasury issues. This pattern may be attributed to short positions in Treasury securities being employed by dealers to hedge other long positions in corporate, agency and mortgage bond exposures at that time.

Figure 6.11: Primary Dealer positions (NY Fed, Haver Analytics)



6.21 The basis risk involved in hedging corporate positions with Treasuries has on occasion been the source of substantial losses. In 2008/2009, US Treasury yields fell while corporate bond spreads and yields moved higher, resulting in substantial losses for those who were long corporates (which declined in price) and short Treasuries (which rose in price) as interest rate hedges of those corporates.

6.22 A Federal Reserve study of this phenomenon, which examined a number of possible hypotheses concluded: "*The evidence here is thus more consistent with other investors proactively increasing their*

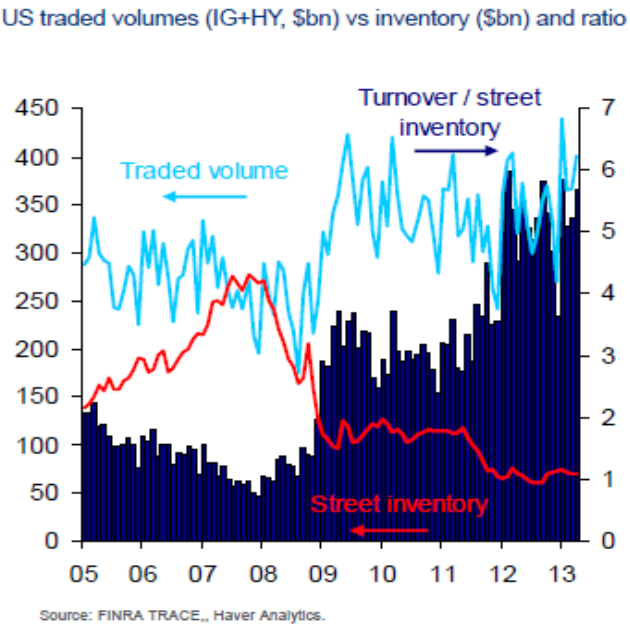
participation at auction, and with the technical rule change[42] *perhaps having some effect, and not with dealers becoming more risk averse and demanding greater compensation for intermediating new supply. Results of the ten-year-note auction on December 12 also fit this pattern better. The note was sold at a yield of 1.65 percent, 2 basis points below the 1.67 percent yield in the secondary market at the time, suggesting that the low level of dealer purchases wasn't attributable to low dealer demand, but rather to high demand by other investors*."

6.5 Dealer positions

6.23 Perhaps the most important aspect of dealers' corporate and agency positions is their pronounced decline post 2007. This might be considered surprising given the high volumes of successful primary issuance.

6.24 The levels of trading activity in corporate bonds (both investment grade and high yield) have risen markedly in the post crisis period (Figure 6.12) while dealer inventories in these have declined. Increased velocity or flow has been accommodated using a smaller inventory or stock of liquidity. The turnover to inventory ratio (shown by the solid dark blue bar in figure 6.12 measured on the right hand axis), which may be considered an efficiency measure, has moved from the one to two times range to now be between five and six times. It is an open question as to whether this trading or intermediation strategy is more profitable for dealers than the previous proprietary trading and inventory strategy.

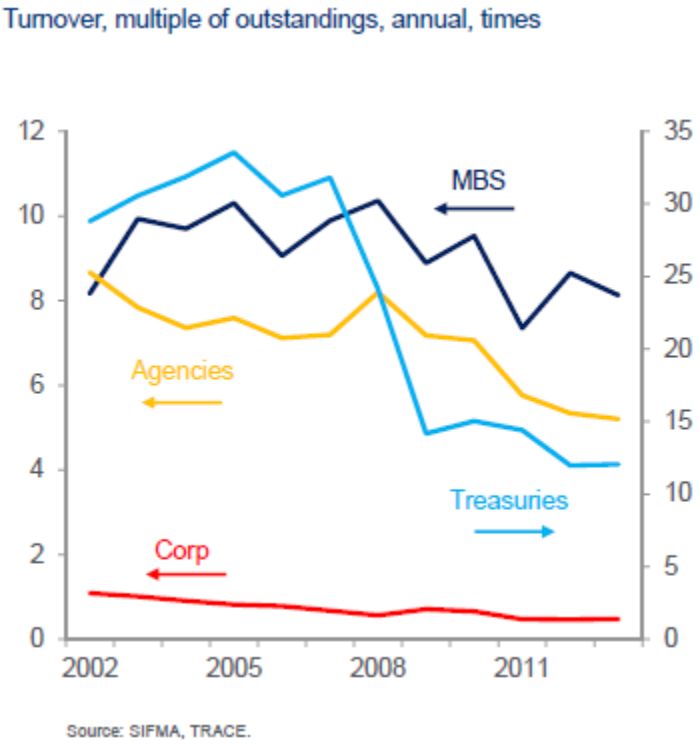
Figure 6.12: Corporate bonds traded volumes and inventory (FINRA, TRACE, Haver Analytics)



6.25 However, traded volumes as a proportion of outstanding have been falling for most bond classifications as can be seen in Figure 6.13. The discrepancy between the increased dollar volume of corporate bonds shown in Figure 6.12 and the minor declines evident in figure 6.13 is explained by the very high issuance of corporate bonds in the post-crisis period.

[42] In June 2009, a change in how US Treasury auction purchases are reported was effected, which eliminated an earlier auction rules provision, whereby a dealer bid fulfilling a "guaranteed bid" to a customer was attributable in the reports to the dealer and not the customer. This provision had been instituted when the Treasury sold securities via multiple-price auctions, but was deemed unnecessary in the current single-price auction environment.

Figure 6.13: Annual turnover as proportion of outstanding stock. (FINRA, TRACE)

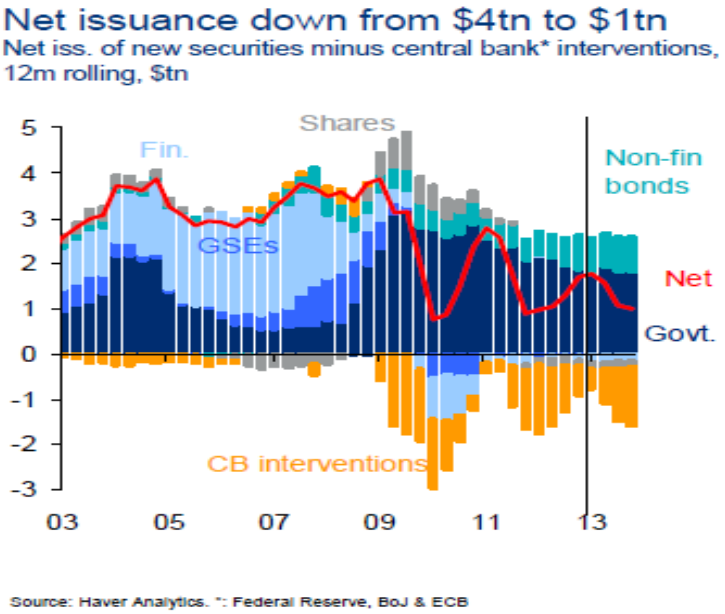


6.26 The ratios in figure 6.13 can be a little misleading. Even though US Treasury turnover has fallen by more than half, US Treasuries are still more heavily traded than any other category of bond and account for more than 50% of all activity.

6.27 The advent of unconventional techniques in monetary policy, such as the use of quantitative easing by the Bank of England and the Federal Reserve, has to a degree inflated turnover figures in recent times. There is also the question as to whether the securities held by central banks should really be considered as part of the stock outstanding.

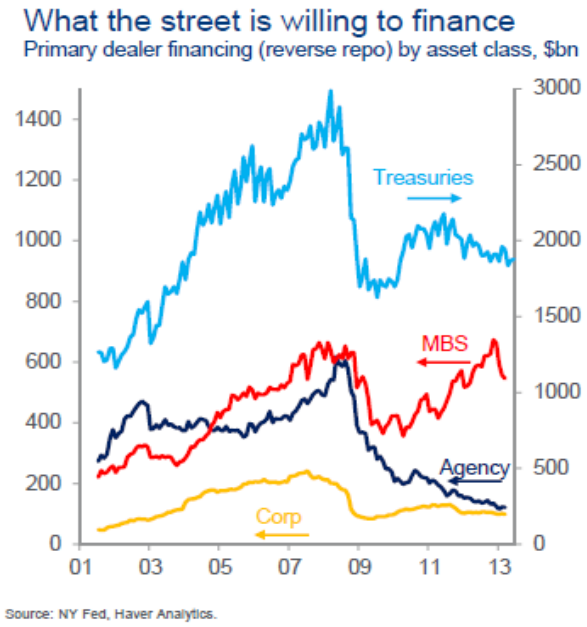
6.28 Globally, the issuance of financial securities net of central bankinterventions has fallen significantly (Figure 6.14), with government sponsored enterprises now almost totally absent from markets. It is notable that government securities and corporate issuance have risen markedly. Equity issuance by contrast is once again negative with more equity being repurchased than issued.

Figure 6.14: Net issuance of financial securities (Haver Analytics)



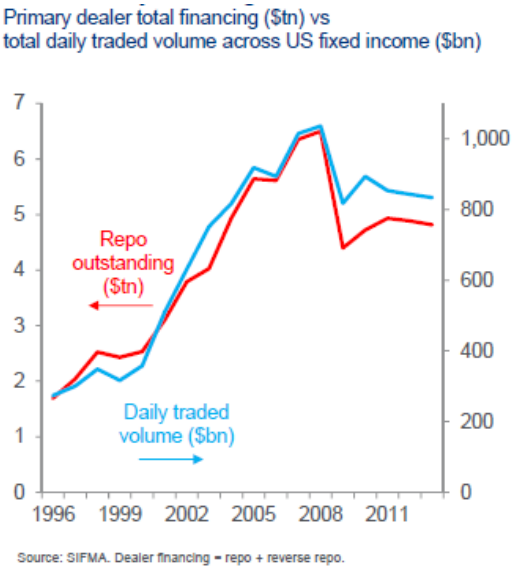
6.30 The US primary dealers have also decreased their supply of short-term finance to others through reverse repo, as is illustrated in Figure 6.15. The notable exception to this is their financing of mortgage-backed securities, which has increased from a post-crash low of US $400 billion to around US $ 600 billion recently.

Figure 6.15: Supply of finance by reverse repo (New York Fed, Haver Analytics)



6.31 Primary dealer financing of own inventories by repo has declined relative to turnover in the post crisis period (Figure 6.16). Having maintained inventory financing by repo at a relatively stable ratio to daily turnover in the pre-crisis period, in the period since, turnover has been a higher proportion of inventory. From the pre-crisis high of US $6.5 trillion, US dealer financing by repo is now around US $4.5 trillion.

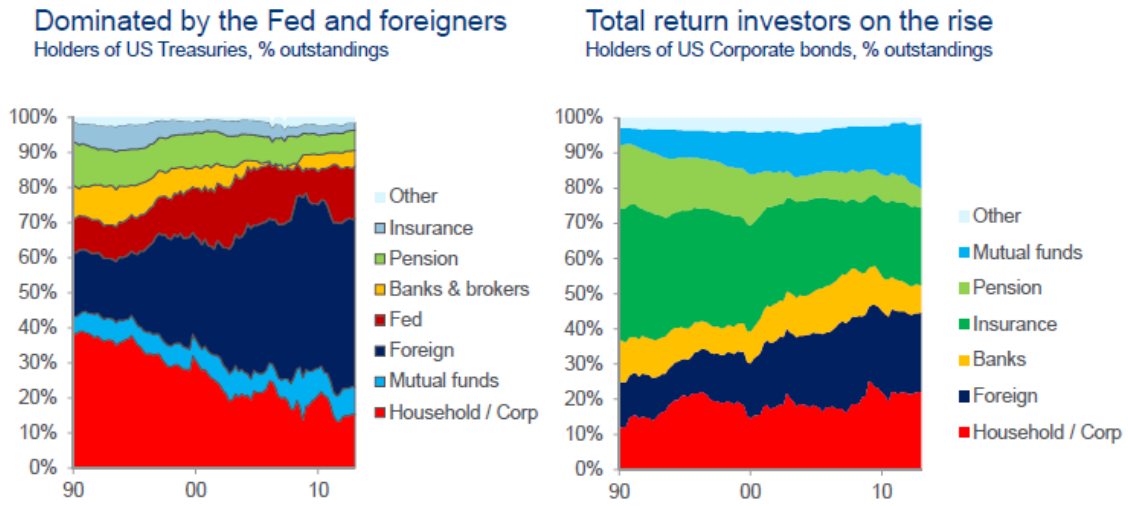
Figure 6.16: Repo and turnover for US primary dealers (SIFMA)



6.7 Non-dealer positions

6.32 The distribution of holders of US dollar denominated bonds has varied markedly over the decades (Figure 6.17)

Figure 6.17: Holders of US Treasuries and Corporate Bonds - % Outstanding.



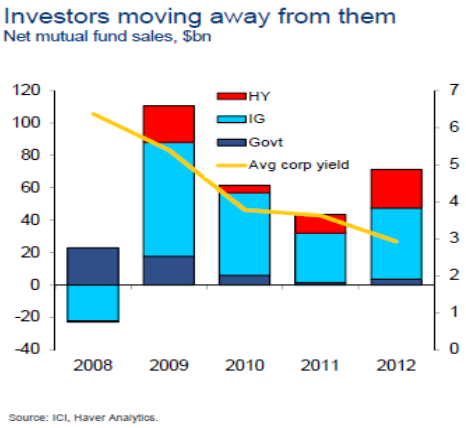
6.33 US Treasuries are now predominantly held by the Federal Reserve and foreign investors, among whom official accounts are highly significant. Households and pension funds have not kept pace and their proportional holdings have declined. Mutual funds have increased their exposure both absolutely and in proportion. Bank and broker holdings have increased since the crisis.

6.34 As the Federal Reserve withdraws from quantitative easing, there may be something of a challenge emerging. With China and the Asian reserve holders experiencing reduced surpluses with the US, they are unlikely to pursue Treasuries on their previous scale. The oil-producing nations are already experiencing reduced sales to the US, reflecting the supply of domestic shale gas. These trends may require increased interest in Treasuries on the part of US domestic investors.

6.35 By contrast, households have been increasing their holdings of corporate bonds, as have mutual funds, whichare themselves predominantly held by households. Pension and Insurance company holdings have not kept pace, and have declined in relative terms. Bank holdings have declined in the post crisis period.

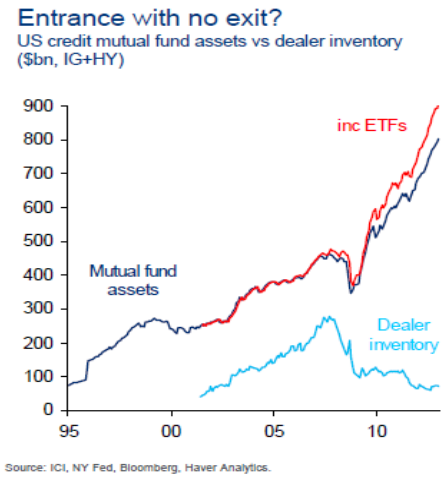
6.36 US retail investors have been moving away from US Treasuries and to credit-based investments even in the face of falling corporate bond yields, as is shown in Figure 6.18 – a relative yield game.

Figure 6.18: Net bond mutual fund sales – the move from governments to corporate bonds (ICI, Haver Analytics)



6.37 This retail trend does give rise to a liquidity concern (Figure 6.19). The decline in dealer inventories relative to the rapid increase in credit mutual funds suggests that these funds may be difficult and perhaps impossible to liquidate other than at fire sale prices into the street when retail investors wish to realise them. This leads us to reprise our statement from the start of this section that liquidity is fine until it is needed!

Figure 6.19: Credit mutual funds and dealer inventory (ICI, NY Fed, Bloomberg, Haver Analytics)



7. Policy and regulation

7.1 Much liquidity transfer occurs in regulated markets, and as shown in section 6 a high proportion of global assets are government bonds. Government policy and regulation are therefore crucial to how liquidity is transferred within the financial system and further on to the real economy.

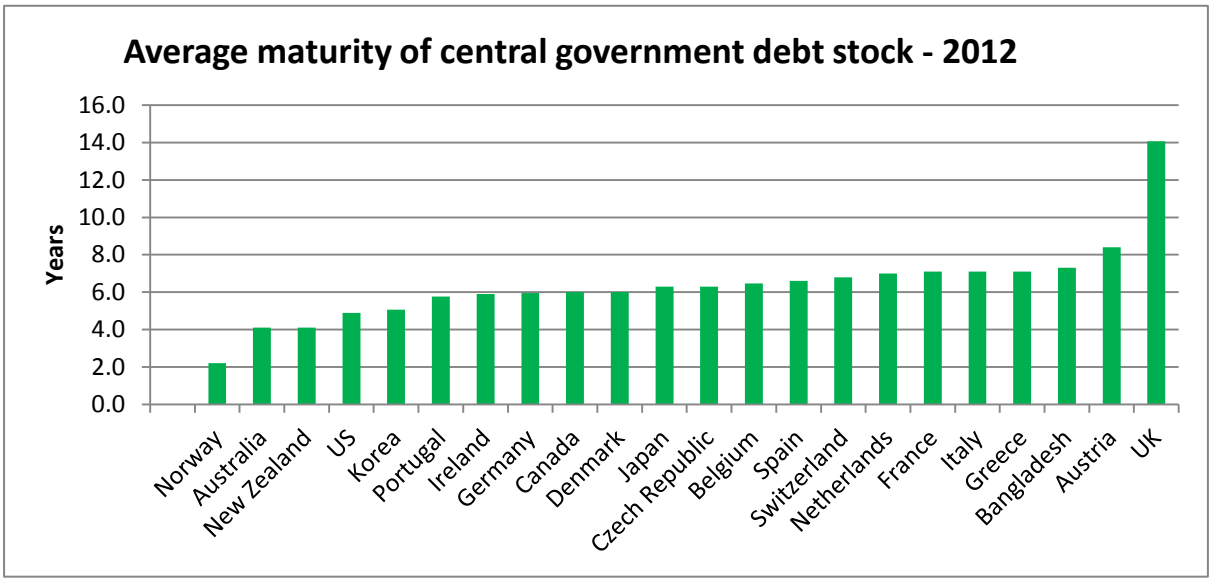
7.2 Both transactions and capital flows are important route for the movement of liquidity. As we set out below the jury is still out on the merits or otherwise of international movements in capital. Furthermore, in a world of uncertainty, the banking system may rationally not provide adequate liquidity. So the flow of liquid funds theoretically should be, and in practice is, constrained by national and international regulations and norms. Much of the flow between market participants is to transform the term of liquidity supply and demand. This maturity transformation can occur in the banking sector or in financial markets, with different merits for each. It is also worth remembering, as we consider whether liquidity regulation actually improves liquidity, Charles Goodhart's note that "*Required liquidity is not true liquidity.*" As an aside, the same can be said for capital as a loss-absorbing buffer on a going concern basis.

7.3 In this final section, we start in 7.1 by looking further at the issuance of government debt, and the purchasers of this debt. We go on to consider global liquidity in 7.2 and regulation in general in 7.3 before considering regulation of liquidity in particular in 7.4. Finally we look to the future of regulation in 7.5, and consider how transparency may or may not help markets serve society, reprising the discussion we started in section 2 as it appears likely that concerns such as these will to a large extent determine whether or not the post crisis regulatory liquidity regimes prove successful or not.

7.1 Liquidity and Primary Issuance

7.4 The maturity of the stock of government debt outstanding influences its liquidity. There is considerable variation of maturity across countries with the UK having by far the longest average maturity (Figure 7.1).

Figure 7.1: Maturity of Debt Stock (OECD and Bangladesh Bank)



7.5 Debt management offices and central banks issue in a wide range of formats: conventional coupon, strippable, inflation-linked, floating rate and term annuity. National savings may even have elements of

gambling and lotteries attached to them –e.g. Premium Bonds. The form of issuance is usually chosen to match perceived investor demand and so reduce the cost of issuance.

7.6 In addition, most countries offer some form of 'national savings' instruments targeted at individuals. These are usually not tradable but may have early surrender or redemption features. In some countries, such as Bangladesh, these may cover material proportions of government borrowing.

7.7 From the perspective of the issuer, longer-term borrowing is attractive since it reduces the government's refinancing costs, frequency and dependence upon financial markets, often referred to as "roll-over" risk. This was an issue in the recent sovereign crisis.

7.8 Many commentators then were actively comparing the marginal rate of market prices and applying this to the entire debt stock – this is a misrepresentation. The refinancing need of a sovereign borrower with a uniform five-year average life is in fact just 10% of that stock in any year. New funding (to support current deficits) and this refinancing determine the rate at which the average cost of the entire debt stock rises.

7.9 The extent to which it is possible to borrow for long tenors is determined principally by two things: the degree of development of long-term savings institutions within the country; and, the degree to which these long term investors are subject to mark to market based regulation of liabilities (based to some extent on a 'risk free' government yield curve). UK life insurance companies and increasingly UK pension schemes over the past two decades were historically the dominant holders of long-term UK government debt; UK pension schemes pre 1990 and German insurers who were not subject to mark-to-market measurement methodologies typically would not invest heavily in long-term Government debt. In some circumstances, long-term issues may be targeted to appeal to short-term investors, such as hedge funds and banks.

7.10 Short term issuance is more heavily focussed upon the banking sector and general insurance. This is used by them as a form of liquidity hoarding and may be explicitly motivated by regulatory considerations. Corporate treasuries may also be active in short term issuance as these securities have good liquidity hoard properties.

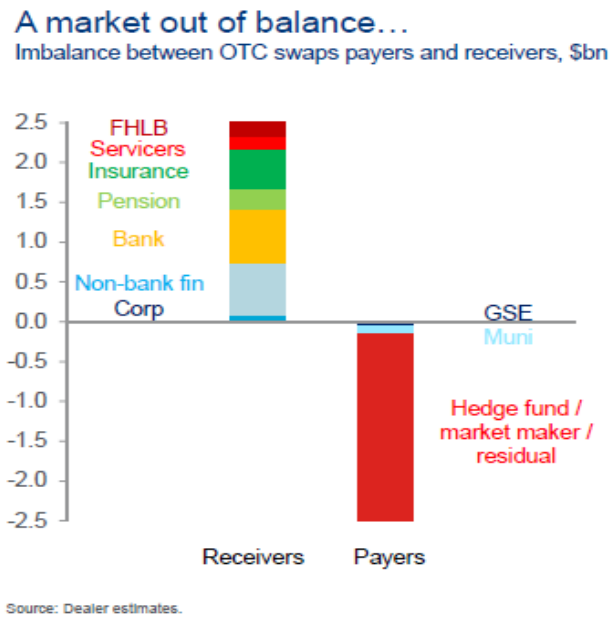
7.11 In many developing nations, the financial system and securities markets may be absolutely dominated by banks, with few or no insurance companies, mutual funds or pension savings.

7.12 International investors have grown to be a very important factor in many developed markets, such as the US and UK as can be seen for the US from the earlier Figure 6.17. When they acquire the prominence evident in the US or UK, if they are a homogenous group, they begin to reduce the diversity of the market. The Herfindahl concentration index[43] for the US Treasury market has risen from 0.22 in 1990 to 0.30 recently. It should not be overlooked that overseas investors must first acquire the currency, which may be a result of trade flows or active portfolio decisions.

7.13 Until 2008 AIG was certainly the poster child for issues of homogeneity or effective concentration within a market, in that case the credit default swap market. This situation is not unique, as may be illustrated (Figure 7.2) by the market for OTC interest rate swaps in the US. The Chinese government bond market is 67% owned by the commercial banks and has a Herfindahl concentration index value of 0.59. In addition, the Chinese commercial banks account for over 75% of all secondary government bond trading.

[43] The Herfindahl concentration index is defined as the sum of the squares of the market shares of the 50 largest participants (or over all firms if there are fewer than 50) within the markets, where the market shares are expressed as fractions. The result is proportional to the average market share, weighted by market share. It can range from 0 (many very small participants) to 1 (a single participant).

Figure 7.2: OTC swap payers and receivers.



As previously, GSE are government sponsored enterprises, and FHLB refers to the Federal Home Loan Board.

7.2 Global Liquidity

7.14 In a global context, beyond central bank activities in liquidity provision, it is the overall demand for credit and the global supply of savings that determine systemic liquidity in practice[44]. The question is not simply of the volume of savings but also of their term relative to the investment demands in an economy.

7.15 The demands stem from industry, government and households. Where mismatches in term occur, they usually involve shorter terms for savings, for example precautionary savings, than for the uses of funds. It is possible to debate the relative merits of maturity transformation in each of these sectors and indeed whether the maturity transformation is better conducted in the banking sector or in financial markets.

7.16 In section 4, we distinguished between financing productive investment and financing consumption (which includes most household mortgages). This is to some extent a false distinction in that both supply and demand may need financing in order to optimise growth; the question is overwhelmingly one of degree and the consequences for inflation. Sustainable consumption smoothing is usually desirable; it is not especially important whether this is financed from savings or borrowings.

7.17 The financial crisis did throw up a related liquidity issue; that of lending in foreign currencies. As access to money markets became limited, the central banks co-operated and made currency swap lines available among themselves and in turn to banks within their jurisdictions.

7.18 In recent times, capital controls have resurfaced as a mechanism for moderating international flows. This has largely stemmed from the earlier experiences of the Asian crisis of 1997-98. Paradoxically, this was coincident with the IMF's desire to amend its charter to include capital account liberalisation, which it failed to achieve. The IMF's original charter prohibited controls only on international trade, interest payments and profits.

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[44] This apparently contradicts the statement in section 2 that there is no need for pre-existing savings (or deposits). Banks seeking savings deposits to meet their funding needs are seeking to redress imbalances arising from the expenditure of loans and liquidity already advanced.

7.19 To quote from the Economist (October 2013): "*The consensus in favour of capital mobility has always been less clear-cut than that in favour of free trade, for two main reasons. First, capital flows can push a currency far above its intrinsic value, widening the trade deficit and hollowing out domestic manufacturing. Second, they can fuel borrowing booms, especially in countries with underdeveloped financial systems, leading to devastating busts when the money flows out*."

7.20 The Committee on the Global Financial System observed "*despite the numerous cross-country attempts to analyse the effects of capital account liberalisation, there appears to be only limited evidence that supports the notion that liberalisation enhances growth*."

7.21 Recent academic work, such as that of Helene Rey at London Business School, has argued that due to the size and volatility of portfolio capital flows, even with a flexible exchange rate, it is not possible to run an independent monetary policy without capital controls. This view resonates well with those of us who can remember the trials and tribulations of the UK in the 1960s and 1970s and the role of the overseas Sterling balances.

7.22 The effect (and arguably cause of the extent) of the financial crisis in this international dimension can be seen from the behaviour of international claims (i.e. cross-border credit) (Figures 7.3, 7.4), which was markedly different from domestic. The growth rate of domestic claims moderated slightly but remained positive, while the growth rate of international fell from a high of plus 20% in the third quarter of 2007 to minus 10% in the first quarter of 2009.

Figure 7.3: Evolution of aggregate international claims (BIS, Internaltional Banking Statistics)

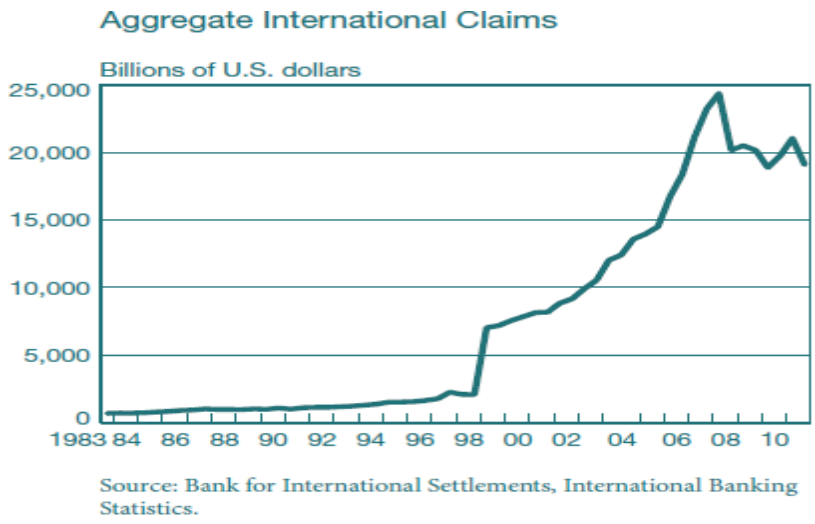
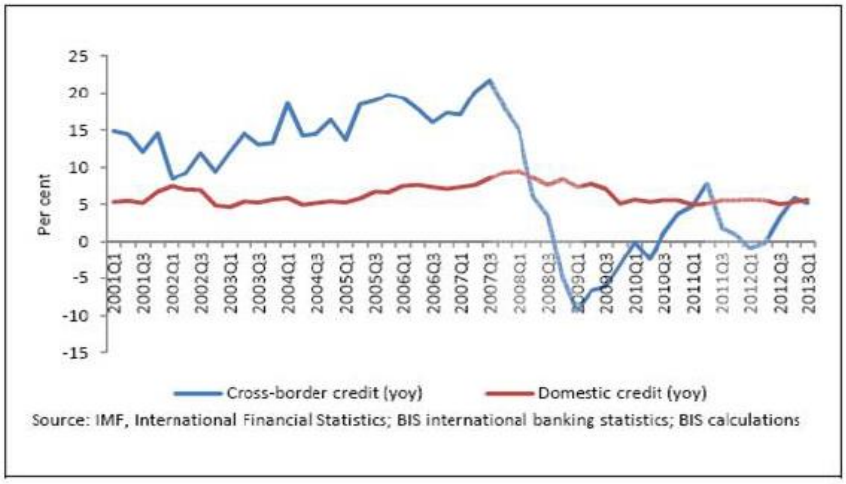


Figure 7.4: Year on year growth in claims (BIS, IMF)



7.23 The sovereign debt crisis that emerged in the wake of the sub-prime crisis threw up the possibility of sovereign default and indeed saw instances of restructuring of Greek government bonds. As this has been discussed and analysed elsewhere ad nauseam, we shall confine ourselves to just a few salient points.

7.24 The Eurozone nations were effectively borrowing in a foreign currency, as they could not create it when necessary; so unwilling default became possible. These nations also did not have control over the flows of funds across their national borders. In effect many residents saw a euro held in a German or French bank as superior to a euro held in Spain, or Greece.

7.25 Although sovereign entities should not in general be modelled as if they are corporations or households, the analysis of their ability to service their debt follows some common strands. The ratio of debt to EBITDA is a primary indicator of financial stress for a corporate group, but this is net external debt and excludes inter group loans. The debt to GDP ratio, which figured so prominently in the Maastricht criteria and in analyses of the peripheral sovereigns' debt sustainability, is a gross debt figure. The net figure would be debt held externally, which is only a small proportion of the gross figure.

7.26 More salient metrics for sustainability might be external debt to national wealth, which might be complemented by debt service to national income, given a state's regalian powers. With the publication of Piketty's "Capital in the 21st Century", national wealth estimates for some countries are now more widely available.

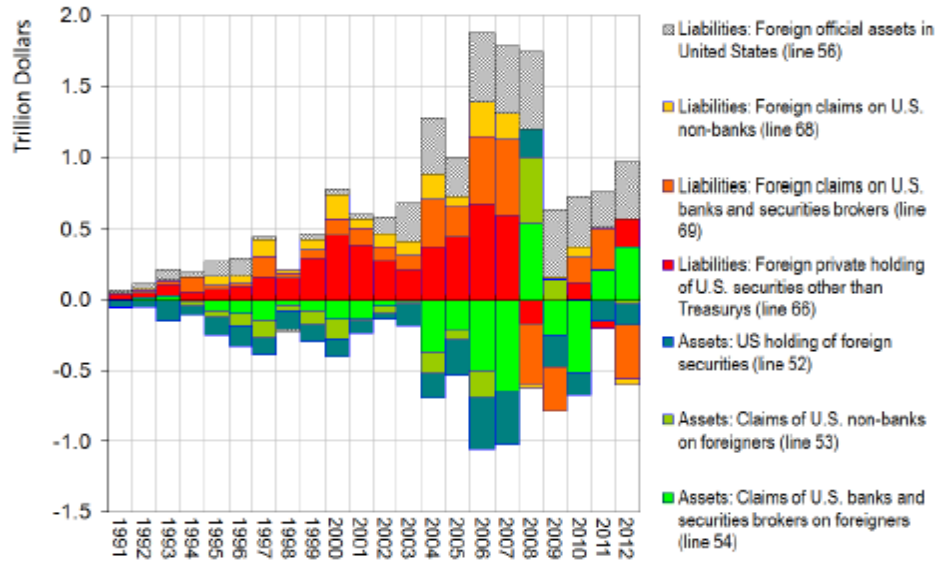
7.27 In the wake of the crisis, there has been a heavy regulatory focus upon liquidity in a global context. The executive summary of the BIS (2011) is a good, if dense, introduction to the issue and questions of global liquidity. It covers the relation between official and private sector liquidity, and how this may be assessed and understood in both good times and bad.

7.28 Recalling the arguments in section 2, when a bank advances a loan it credits the debtor's account with money and if the debtor's use of these funds is confined to payments within the bank, the transaction requires no further action; it is simply internal bookkeeping within the bank. However, when the debtor wishes to make a payment to someone who holds his or her accounts at another bank, then the debtor's bank must make this payment through the central bank using reserves at the central bank to that other bank. The question then arises as to whether the debtor's bank has these reserve funds available – the one to one nature of inside and outside money becomes evident.

7.29 It is perfectly possible for imbalances among banks to arise in the holding of reserves at the central bank and for liquidity to be locally impaired. For example, one bank may be hoarding liquidity while another is short. The claims under the credit support agreements of sub-prime derivatives in the early crisis period were so substantial that the flows led to significant imbalances between banks and in turn fed back into market prices.

7.30 Much recent academic and supervisory research has focussed upon the analysis of these problems using such methods as global flow of funds analysis and concepts such as core and non-core deposits. The flow of funds for the US is shown as Figure 7.5 below. This recent research suggests that idea that the advance of the loan creates the money is side-lined by the view that advances are restricted by the amount of deposits already held, which some argue is closer to the manner in which bankers view the situation and operate. These newer approaches are quite severely constrained by incomplete and inadequate data. In part, this view was motivation for the net stable funding ratio introduced in the Basel III regulations, discussed further in section 7.4 on liquidity regulation.

Figure 7.5: Annual Capital Flows US



7.31 In a world of uncertainty, the banking system may rationally not provide adequate liquidity; for example, bankers may abandon projects to which they have advanced funds if developments occur requiring further funding from them where project returns are insufficient. The abandonment of the project involves the crystallisation of losses and capital wastage, as highlighted in section 5.3. Such shortfalls introduce an explicit role for central banks as liquidity insurers of last resort.

7.32 While the money in circulation is the liquidity stock, in addition to these transaction balances, there is a further source of liquidity in the form of undrawn overdrafts and other facilities such as committed lines of credit. These credit elements also make it obvious that the money or liquidity stock is not some fixed and settled amount.

7.33 Idiosyncratic events can radically alter the value of a security as a store of value and hoard of liquidity. An event such as BP's Gulf of Mexico oil spill and fire radically increased the sensitivity of its debt and equity to new information. It is notable that such liquidity events are frequently accompanied by high levels of trading activity as those owners for whom the liquidity hoard characteristic was paramount sell and other investors and dealers buy.

7.34 System wide events can also occur. Breakdowns in payments infrastructure can result in imbalances between banks and liquidity events occur. However, systemic events are usually the consequence of developments in the international dimension resulting from trade and capital flow movements. This is usually compounded by the requirement to have access to the foreign currency, and central bank interventions in the foreign exchange markets are commonplace. It is also usual for a central bank buying its own currency in the foreign exchanges to intervene to sterilise the resultant increase in liquidity in its own currency by, for example, the issuance of bills removing it.

7.35 It is notable that negative events can have near instantaneous effects while bubbles take time to build. It is usual to capture some aspects of these liquidity concerns with volatility type measures, such as trading spreads. Volatility measures typically have low forecasting or predictive power (Bank of England, 2014); the efforts of the regulators and central bankers are now focussed on estimating the degree of development of bubble conditions. Whether the authorities will prove, when they have these measures in place, to have the willpower to take away the punchbowl is far from obvious.

7.36 Committed lines of credit and undrawn facilities are a form of liquidity insurance though written by a private bank rather than the central bank. The extent to which a bank may write these depends in large part on the extent to which this liquidity will flow outside of its depositor base to other banks, and the extent to which that bank is prepared when necessary to draw upon the central bank at the discount window.

7.37 For whatever reason such discount window borrowing is usually perceived to carry some stigma and possible contagion in inter-bank and other normal market operations. This stigma concern is also evident at the sovereign level, with many countries unwilling to call upon the IMF or other official liquidity facilities, or even to arrange these facilities.

7.38 Discount window stigma was also relevant in the context of small and medium sized enterprises (SME) financing in the UK. It used to be standard practice for SME working capital facilities to be called and refinanced by the issuance of bills when liquidity became tight for their lending banks. These bills were then endorsed by the lending bank and presented at the discount window. This made SME lending an attractive proposition to the banking sector as this lending could reliably be refinanced but the 'modernisation' of the UK money markets saw the demise of the Discount Houses and the discontinuance of these practices. Access to bank lending by SMEs appears to have suffered in result.

7.39 The liquidity that changes hands in financial markets is all held in the banking system. The amount of liquidity available in any market arises from the extent to which market participants have access to this liquidity.

7.40 What characterises financial markets is the greater diversity of participants and decision-makers active in them. These vary from market segment to market segment; the contrast between banks and insurers is interesting in this regard. Banks invest the proceeds from taking on liquid liabilities, which may run, into illiquid assets, while insurers invest the proceeds from taking on illiquid liabilities, which may in general not run, into liquid assets.

7.41 Regulation may determine, directly or indirectly, the securities markets in which an institution participates. This may directly be a simple restriction on overseas investments, or it could be, indirect, as in the case of funded pension schemes in the UK. In this latter case, regulation focuses attention on the balance sheet and solvency rather than the cash flows that characterise them, with the result that these funds are now often present in hedging markets, such as derivatives, with an emphasis on short-term balance sheet solvency.

7.42 Different accounting standards can also affect market participation. Historic cost will usually result in institutions that may take profits but not losses; the result is greater activity when markets have done well. A

solvency regime using mark-to-market accounting may induce pro-cyclical behaviour, requiring addition sales as market prices decline (Bank of England, 2014)

7.43 From a financial stability standpoint, the greatest single incentive for debt market participation by issuers is the deductibility from corporate income taxes of interest payments, which subsidises debt versus equity in most countries. It is arguable that removal of the interest cost deductibility concession would greatly enhance global financial stability.

7.3 Regulation

7.44 The regulatory response to the experiences of the financial crisis has been an avalanche of still largely proposed new regulation. This has been both instrumental and institutional, including markets. This cannot but have effects on liquidity, most of which appear to be negative in nature.

7.45 We shall preface our discussion with the caution offered by Charles Goodhart that for regulatory-mandated liquidity to be effective, it needs to be usable liquidity. "*The most salient metaphor and fable in prudential regulation is of the weary traveller who arrives at the railway station late at night, and, to his delight, sees a taxi there who could take him to his distant destination. He hails the taxi, but the taxi driver replies that he cannot take him, since local bylaws require that there must always be one taxi standing ready at the station. Required liquidity is not true liquidity.*"

7.46 This caution is concerned with more than the economic inefficiency of holding liquidity or a taxi unutilised; it highlights another point that is also evident in the insurance capital markets. An insurance linked security that has experienced a claim cannot, unless replenished in some way, provide afterwards the same cover as it originally had, and indeed, may be entirely unable to offer any cover.

7.47 Given the cost of holding liquidity, it is to be expected that, left to their own devices, financial institutions will tend to minimise their holdings of liquidity stores and under-provide for these contingencies. It should be recognised that these holding are a form of self-insurance, and insurance is costly. Adopting the attitude that the market will always provide results in under-provision of liquidity, with the consequence of an increased likelihood of exposure to illiquidity in times of market turmoil.

7.48 Over-providing is a symptom of poor corporate governance. Economically the rationale for (good) corporate governance is that it maximises the quantity of future cash flows that may be pledged or, equivalently, that will be recognised in valuations.

7.4 Liquidity Regulation

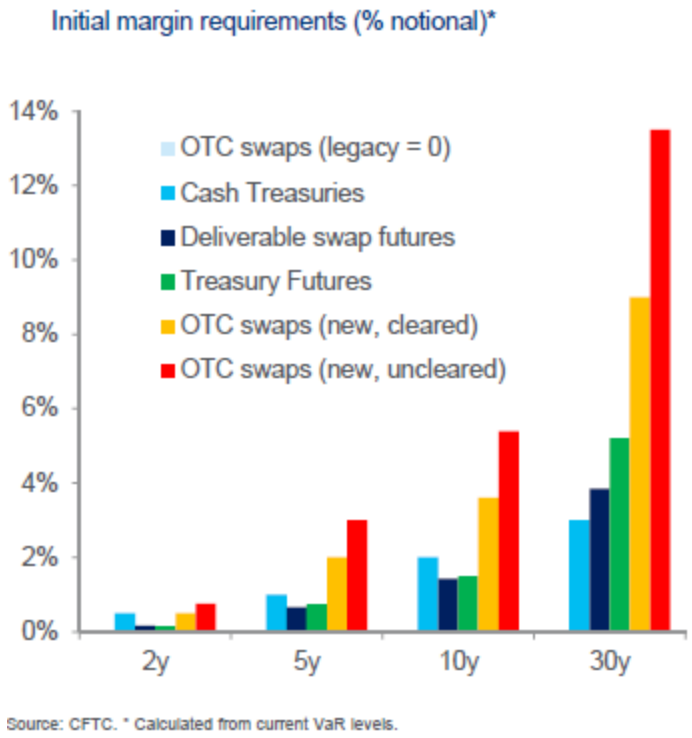
7.49 While this paper is concerned principally with aspects of liquidity, it should not be forgotten that the response to the crisis has included actions in many other areas, which include bank resolution, deposit insurance, supervision, transparency and disclosure requirements, as well as reserve and capital requirements and central bank lender of last resort arrangements. Any or all of which may affect liquidity conditions, locally or globally.

7.50 Reserve and capital requirements can limit credit creation and depending upon the detail of their implementation can affect the distribution of credit and credit creation within an economy. The debates over central bank policies such as quantitative easing have been so widespread that we will not revisit them.

7.51 These detailed rules provide incentives not just for banks to hold particular types of asset, but also for the ways in which they manage their business. Figure 7.6 below shows the initial margin requirement for a

variety of contracts of selected tenors. These have provided incentives for activity in swaps to migrate to futures, and to a much lesser extent for cash Treasury activity to migrate to futures. It is also evident that there are implicit costs arising from the term structure, which will in turn be reflected in the costs of maturity transformation.

Figure 7.6: Initial margin requirements by baturity (CFTC)



Source: CFTC. * Calculated from current VaR levels.

7.52 Regulatory definition of the risk weights of assets will similarly offer differential incentives for differing classes of assets to banks and other regulated institutions. This is particularly relevant in the context of the net stable funding ratio discussed later.

7.53 Given the centrality of influence over both the magnitude and composition of bank and other financial institutions' balance sheets, it is perhaps surprising that the risk weights applicable have not become a direct decision and control variable for regulators and supervisors. This could also be applied to the liquidity dimension by specifying ex ante the total amounts and haircuts that would be applicable under central bank liquidity facilities.

7.54 For banks, regulation has introduced two principal liquidity measures, the liquidity coverage ratio and the net stable funding ratio, in addition to radically revising the risk based solvency regime. In some jurisdictions, there have also been moves to lower the degree of bank involvement in secondary capital markets, through for example the Volcker rule.

7.55 The liquidity coverage ratio (LCR) is defined as the ratio of high quality liquid assets to total net cash outflows over the next 30 days in a liquidity stress scenario, which for management purposes must be greater than 1. High quality liquid assets are themselves defined, and some assets are entirely excluded, while varying haircuts of market value (0%, 15%, 25%, 50%) are attributed to others. Table 7.1 shows the criteria, characteristics and metrics that are suggested by the Basel Committee on Banking Supervision.

Table 7.1: Liquidity criteria, characteristics and metrics

	Characteristic	Criteria	Examples of metrics/measures
Asset characteristics	Asset quality	Probability of default	Ratings
			Spreads
			Price drops during distress
		Flight to quality (performance during distress)	Performance relative to risk-free asset
			Correlation with financial stress
		Volatility	Implied and actual volatility
			Duration/time to maturity
	Transparency and standardisation	Collateral eligibility	Eligible/haircuts at FMIs*
			Across private counterparties
		Standardisation	Small number of standardised product types
			Standardised risk modelling
			Well understood risk properties
		Price transparency	Pre-trade pricing broadly available
			Post-trade pricing broadly available
Market structure characteristics		Trading venues	Electronic (including hybrids)
			Exchange-traded
	Active and sizeable market	Size	Volumes (number of trades and dollar value)
			Outstandings
		Related financing markets	Repo financing available
			Other secured/forward financing
			Related hedging markets
		Market participation	Breadth of investors (low concentration)
			Large number of active market makers
Market liquidity	Liquidity	Depth/price impact of trading	Amihud ratio(price changes relative to volume)
			Autocorrelations of returns
		Breadth	Effective bid-ask spreads (ex post)
			Quoted bid-ask spreads (ex ante)
		Immediacy	Average number of trades per day
			Number of days with zero return/volume

* Financial Market Infrastructures – FMIs could include payment systems, central securities depositories, securities settlement systems, trade repositories and central counterparties.

7.56 The net stable funding ratio (NSFR) is an attempt to capture the sensitivity or funding risk of a bank. It is defined as the ratio of the available amount of stable funding to the required amount of stable funding over a time horizon that extends to one year. The required amount is again determined by the composition and amount of bank assets and includes off-balance sheet items. It is concerned with funding tenor, type and counterparty. The behavioural characteristics of the counterparty are relevant as different types of counterparty can be expected to exhibit different degrees of deposit 'stickiness', with wholesale market funding being more flighty that retail deposits.

7.57 While the details of assets follow closely the definitions and weightings of the liquidity coverage ratio, the available stable funding factor has weightings that are summarised in Table 7.2 below.

Table 7.2

ASF factor	Components of ASF category
100%	• Total regulatory capital • Other capital instruments and liabilities with effective residual maturity of one year or more
95%	• Stable non-maturity (demand) deposits and term deposits with residual maturity of less than one year provided by retail and SME customers
90%	• Less stable non-maturity deposits and term deposits with residual maturity of less than one year provided by retail and SME customers
50%	• Funding with residual maturity of less than one year provided by non-financial corporate customers • Operational deposits • Funding with residual maturity of less than one year from sovereigns, public sector entities (PSEs), and multilateral and national development banks • Other funding with residual maturity of not less than six months and less than one year not included in the above categories, including funding provided by central banks and financial institutions
0%	• All other liabilities and equity not included in above categories, including liabilities without a stated maturity • Derivatives payable net of derivatives receivable if payables are greater than receivables

7.58 The Basel Committee for Banking Supervision offers a tiered checklist that may be considered as one way to operationalise the criteria and metrics of Table 7.1. This is reproduced below as Table 7.3. This matrix is partitioned somewhat arbitrarily into calculated metrics, data-dependent metrics, as well as basic and fundamental, while trying to capture also asset and market characteristics.

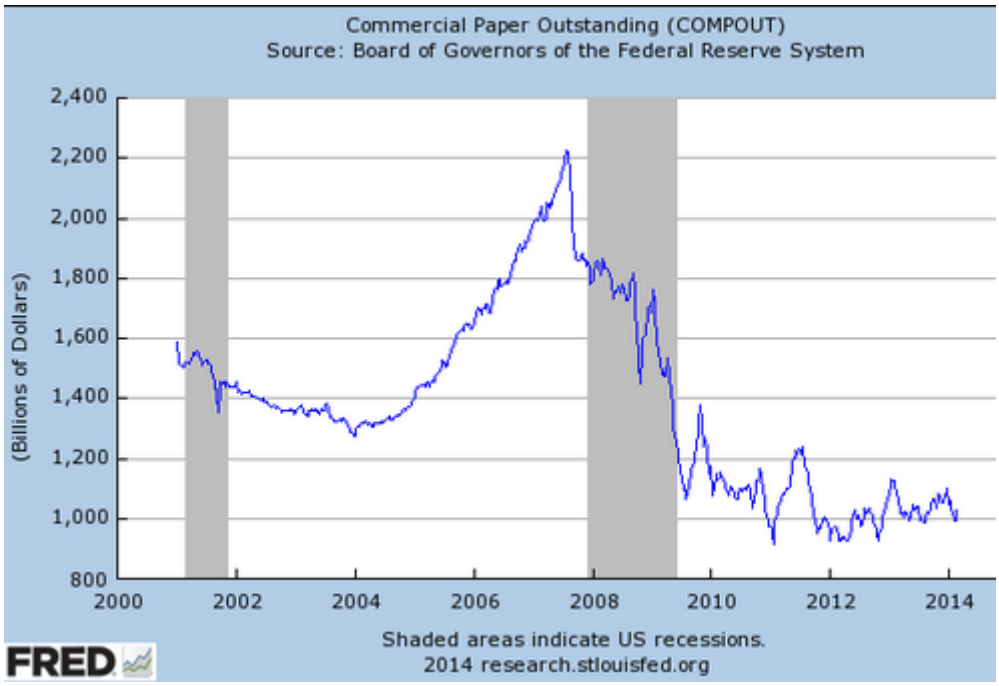
Table 7.3: Tiered checklist of market based indicators of liquidity

	Characteristic	Calculated Metrics	Data-Dependent Metrics	Basic Metrics	Fundamental Metrics
Asset characteristics	Asset quality	Option-adjusted spreads	Ratings		Is it rated by a ratings agency recognised in the jurisdiction?
		Duration	Time to maturity		
		Correlation with financial stress	Are there large price drops during distress?		
		Implied and actual volatility			
		Performance relative to risk-free asset			
	Transparency and standardisation		Haircuts At FMIs	Eligible at FMIs?	Denominated in a convertible currency?
				Eligible at private counterparties?	
				Small number of standardised product types?	
				Well understood risk properties	
				Pre-trade pricing broadly available?	
				Post-trade pricing broadly available?	
				Standardised risk modelling?	
Market structure characteristics	Active and sizeable market		Volumes (number of trades and dollar value)	Electronic trading (including hybrids)?	
			Breadth of investors (low concentration)	Exchange-traded?	
			Outstandings	Large number of active market makers	
				Repo financing available?	
				Other secured/forward financing?	
				Related hedging markets?	
Market liquidity	Liquidity	Autocorrelations of returns	Returns		Pricing formula inputs publicly available?
		Number of days with zero return/volume			
		Roll Metric			
		Amihud (price changes relative to volume)			
			Average number of trades per day		
		Effective bid-ask spreads (ex post)	Quoted bid-ask spreads (ex ante)		

7.59 Even though the NSFR will undergo a lengthy period of observation before being introduced, it is clear that much more market attention will be focussed on liquidity and high quality liquid assets than previously. Some have suggested that banks will face a shortage of high quality short-term assets. While is it true that the share of US Treasury Bills in total marketable stock has been declining, and that commercial paper outstanding has also declined markedly (Figures 7.7 and 7.8), the commercial banks have excess reserve assets at the central bank.

Figure 7.7: US Treasury bills decline as a proportion of outstanding debt (US Treasury)

Figure 7.8:



7.60 The relative shortage of high quality liquid assets is most likely to be felt in other areas such as money market funds. However, here we can expect the new Federal Reserve overnight reverse repo facility to come into play; this is effectively an overnight deposit facility with the Fed. While this facility was perhaps conceived as a sterilisation tool for the nearly $4 trillion of securities it holds, it is likely to have an even greater effect on money market flows.

7.5 Transparency and Liquidity

7.61 Though covering issues of trust in section 2.4, this paper has avoided any extensive discussion of transparency and its role in markets, but as it is clearly an important element in both the Basel Committee formulations, and European Commission pre and post trade disclosure rules, some discussion is appropriate.

7.62 Onora O'Neill (2012) gave a highly insightful account of bilateral trust, and the potential role (or not) for transparency in increasing trust. O'Neill argues eloquently that the current approach to transparency is more defensive risk management than supportive of trade counterparts. As trust is key to liquidity transfer, so O'Neill's analysis of trust is key to liquidity.

7.63 There are also further problems for the advocates of transparency. Disclosure might possibly level the playing field between retail and institutional investors if the disparity is rooted in information availability and collection. However, when the disparity between them arises not from the collection of data but from its processing and analysis, as seems far more likely with institutional investors and indeed is frequently claimed by them, then the information asymmetries between retail and institutional investors are increased by greater disclosure.

7.64 The Akerlof 'lemons' problem of information asymmetry was discussed in section 2.4, Malherbe, (2014) goes one step further and points out that market liquidity is affected not only by news about the overall quality of assets, but also by the market's perceived motives for sellers.

7.65 Suppose that banks' exact liquidity positions are not known by the market, as is usually the case. If market participants expected banks to hoard substantial liquidity, then the market may be subject to much adverse selection and break down when banks come to sell

7.66 In this situation, the motive for a bank selling assets must be that they are of low quality, rather than that the banks really need cash. Liquidity hoarding is then self-fulfilling, as banks cannot count on securitization to raise cash and must hoard liquid assets.

7.67 Conversely, a situation in which banks are expected to hoard little liquidity reduces the adverse selection (banks that need to raise cash and are expected to sell high-quality assets). Thus the prospect of a well-functioning securitization market removes the need for banks to hoard costly liquidity.

7.68 It is usual when trying to sell something to attempt to counter this endogenous problem by citing an exogenous motive for the sale – e.g. stating that job relocation drives house sale.

7.69 There is also a topsy-turvy principle here: appearing illiquid is a positive for a bank looking for market liquidity, but a handicap for one that wants to tap funding liquidity. However, it may also conflict with the concerns of the bank over stigma.

7.70 It appears likely that concerns such as these will to a large extent determine whether or not the post crisis regulatory liquidity regimes prove successful or not.

8. Concluding Remarks

8.1 This paper has not considered at any length the fact that many financial institutions owe their existence to, and are designed to, manage concerns with liquidity. The mutual fund pays some or all of its redemption claims from new receipts and can thereby maintain larger exposures to investments than might otherwise be the case. The subscription and redemption terms of private equity and of many hedge funds are also motivated by such concerns.

8.2 Perhaps the greatest omission is that of the corporate treasury in general, other than the cursory introduction in section 5.3. These would not exist were it not for the asynchronicity (and resultant costs) of the demands for and receipts of cash.

8.3 Motivated by regulatory concerns there is more work than ever before being conducted in academia and official institutions on liquidity. However, it is also clear that we have come far in understanding liquidity and recognising it, and that we need no longer take solace in Justice Potter Stewart's dictum (with respect to pornography) that "*we will know when we see it*."

8.4 Perhaps the largest unresolved question concerning liquidity is not: why, in its many incarnations, does it not appear to obey the law of one price, but rather how closely would we like our institutional arrangements to approach that circumstance.

8.5 Some of the other key questions that we have touched upon, and would like to highlight for debate include:

a) How might we better understand money creation and the business cycle, to ward off some of the worst excesses of financial booms and busts?

b) Does liquidity regulation enhance or reduce liquidity for outsiders?

c) How can markets be regulated better to serve outsiders over insiders?

d) How can the worst consequences of mark-to-market balance sheet management be mitigated to aid longer-term investment time horizons and reduce pro-cyclicality?

e) How might institutions better account for liquidity, its value, and their needs when making investment decisions?

f) How can we better assess liquidity, so measures focus on its availability when required, rather than being dominated by analysis of conditions when liquidity is already in ample supply? For instance, does increased turnover really mean increased liquidity in any economically meaningful sense?

g) Do we sufficiently distinguish between a theoretical risk-free rate and an investible one based on liquid securities with an embedded liquidity premium in their price?

h) Do too many actuarial models ignore the option value of liquidity?

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9. Glossary

ABCP (Asset-backed commercial paper) is a form of commercial paper that is collateralized by other financial assets.

ABX.HE indices were launched on 17 January 2006 by CDS Indexco and Markit. They are a subprime mortgage backed credit derivative index on home equity loans as assets. Advertised daily prices were availability on the Markit website. The purpose of the indices is to allow investors to trade exposures to the subprime market without holding the actual asset backed securities. The ABX.HE Index was created from "qualifying deals of 20 of the largest sub-prime home equity ABS shelf programs from the six month period preceding the roll." (http://www.wiley.com/legacy/wileychi/baum/supp/Ch14_ABX_MarketingPresentation.pdf)

ABS (asset-backed security) is a security whose income payments and hence value is derived from and collateralized (or "backed") by a specified pool of underlying assets.

CCP (central counterparty) is an organisation which acts as counterparty to both sides on a trade, clearing and settling the trade.

CDO is a type of structured asset-backed security. Originally developed for the corporate debt markets, over time CDOs evolved to encompass the mortgage and mortgage-backed security ("MBS") markets, while synethetic CDOs used credit default swaps as the underlying assets.

CLOs (collateralized loan obligations) are a form of asset backed securitization where payments from multiple middle sized and large business loans are pooled together and passed on to different classes of owners in various tranches.

CPSS (Committee on Payment and Settlement System) changed its name to the Committee on Payments and Market Infrastructures (CPMI) on 1 September 2014. promotes the safety and efficiency of payment, clearing, settlement and related arrangements, thereby supporting financial stability and the wider economy. The CPMI monitors and analyses developments in these arrangements, both within and across jurisdictions. It also serves as a forum for central bank cooperation in related oversight, policy and operational matters, including the provision of central bank services.

CSD (central securities depository) is a specialist financial organization holding securities such as shares so that ownership can be easily transferred through a book entry rather than the transfer of physical certificates.

Dedication investment strategy involves cash flow matching so that investment earnings in terms of dividends, coupons, redemption payments and other income will provide broadly matching payments for the outgo in terms of liabilities.

Divisia money is an index of aggregate money (i.e. an attempt to measure the change in the money supply), that takes into account the different properties of different elements of the monetary base being aggregated. http://en.wikipedia.org/wiki/Divisia_monetary_aggregates_index

GSE or **government-sponsored enterprise** is a financial services corporation created by the United States Congress. Their intended function is to enhance the flow of credit to targeted sectors of the US economy and to make those segments of the capital market more efficient and transparent, and to reduce the risk to investors and other suppliers of capital. The desired effect of the GSEs is to enhance the availability and reduce the cost of credit to the targeted borrowing sectors (home finance, agriculture and education) primarily by reducing the risk of capital losses to investors. The two most well-known GSEs are the Federal National Mortgage Association, or Fannie Mae, and the Federal Home Loan Mortgage Corporation, or Freddie Mac

HY (high yield) – sub-investment grade debt (i.e. credit rated BB+ and below).

IG (investment grade) - debt credit rated BBB- and higher

Legal tender has a very narrow and technical meaning in the settlement of debts. It means that a debtor cannot successfully be sued for non-payment if he pays into court in legal tender. It does not mean that any ordinary transaction has to take place in legal tender or only within the amount denominated by the legislation. Both parties are free to agree to accept any form of payment whether legal tender or otherwise according to their wishes. See http://www.royalmint.com/aboutus/policies-and-guidelines/legal-tender-guidelines

Lemons are cars of poor quality.

Liquidity means having access to money. Liquidity of an asset is being able to exchange the asset for money. Liquidity of a market is about being able to sell the assets traded on the market for money. A liquidity flow is how "access to money" moves between institutions or markets as they trade or engage in other forms of economic activity.

Market microstructure describes how exchange occurs in markets. Market microstructure research examines the ways in which the working processes of a market affects determinants of transaction costs, prices, quotes, volume, and trading behaviour.

MBS (mortgage backed security) is a type of asset-backed security that is secured by a mortgage, or more commonly a collection ("pool") of sometimes hundreds of mortgages.

NSFR (Net Stable Funding Ratio) – see 7.56.

"**Outside money** is money that is either of a fiat nature (unbacked) or backed by some asset that is not in zero net supply within the private sector of the economy. Thus, outside money is a net asset for the private sector. The qualifier *outside* is short for (*coming from*) *outside the private sector*. Inside money is an asset representing, or backed by, any form of private credit that circulates as a medium of exchange. Since it is one private agent's liability and at the same time some other agent's asset, inside money is in zero net supply within the private sector. The qualifier *inside* is short for (*backed by debts from*) *inside the private sector*." As proposed by Richard Lagos of the Minneapolis Federal Reserve Bank.

Rehypothecation is where a financial market participant reuses the collateral pledged by the counterparty for its own use (such as borrowing or short selling). It is possible because in financial markets the practical implementation of hypothecation is a simple title transfer of the security against cash - together with the promise of opposite transaction in the future (a repo transaction).

Repurchase agreement, also known as a **repo**, or sale and repurchase agreement, is the sale of securities together with an agreement for the seller to buy back the securities at a later date. The repurchase price should be greater than the original sale price, the difference effectively representing interest, sometimes called the repo rate.

Reverse repo is simply the same repurchase agreement from the buyer's viewpoint, not the seller's. Hence, the seller executing the transaction would describe it as a "repo", while the buyer in the same transaction would describe it a "reverse repo". So "repo" and "reverse repo" are exactly the same kind of transaction, just being described from opposite viewpoints.

RMBS (residential mortgage backed security) – see MBS.

(RTGS) Real time gross settlement systems are specialist funds transfer systems where transfer of money or securities takes place from one bank to another on a "real time" and on "gross" basis. Settlement in "real time" means payment transaction is not subjected to any waiting period. "Gross settlement" means the transaction is settled without bundling or netting with any other transaction

Seigniorage is the difference between the value of money and the cost to produce and distribute it. As with so much related to liquidity, seigniorage has time and credit exposure dimensions since money promised in future is subject to a time value delay and the possibility of default.

Tri-party repo is a transaction for which post-trade processing --- collateral selection, payment and settlement, custody and management during the life of the transaction --- is outsourced by the parties to a third-party agent. Tri-party agents are custodian banks. The agent does not change the relationship or risk between parties.

When-issued: securities trade on a when-issued basis when they have been announced, but not yet issued. The transaction is settled only after the security has been issued, so long as the offering is not cancelled. A when-issued market exists where when issued instruments are traded. When-issued markets can provide an indication of the level of interest that a new issue will attract.

WMBA has its origins in the Foreign Exchange and Deposit Brokers' Association (FEDBA) established nearly 50 years ago. Its members cover global markets in many countries and facilitate the overwhelming majority of transaction volumes in the Over-The-Counter (OTC) markets. The Association works on behalf of the inter-dealer broker (IDB) industry to represent their interests and those of the markets in which they operate.

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