

What drives interbank rates? Evidence from the Libor panel¹

The risk premium contained in the interest rates on three-month interbank deposits at large, internationally active banks increased sharply in August 2007 and risk premia have remained at an elevated level since. This feature aims to identify the drivers of this increase, in particular the role of credit and liquidity factors. While there is evidence of a role played by credit risk, at least at lower frequencies, the absence of a close relationship between the risk of default and risk premia in the money market, as well as the reaction of the interbank markets to central bank liquidity provisions, point to the importance of liquidity factors for banks' day-to-day quoting behaviour.

JEL classification: G21, G32.

The functioning of interbank money markets was severely impaired during the second half of 2007. Uncertainty about losses associated with US subprime mortgage-related structured products led large banks to revise upwards their liquidity needs while making them also more reluctant to lend to each other, in particular at longer maturities. Central banks quickly reacted to the dislocations by temporarily increasing the supply of liquidity (see Borio and Nelson in this issue), but conditions in money markets, in particular for maturities beyond one day, worsened again towards the end of the year, triggering further central bank actions. Conditions in those markets improved after the turn of the year, although tensions remained as of mid-February 2008.

This feature analyses the risk premium reflecting credit and liquidity factors contained in the interest rates paid on interbank deposits by large, internationally active banks. The aggregate premium rose sharply in August, and, after some easing in the following months, again towards the end of the year. Disentangling credit from liquidity factors in this risk premium is difficult, as we are not able to observe banks' funding liquidity needs. Our analysis suggests that although concerns about bank credit risk increased at roughly the same time as the risk premium, our measure of credit risk has little explanatory

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power for the day-to-day fluctuations in the premium. Similarly, the cross-sectional dispersion of the premia was largely independent of the perceived risk of default of banks. This could indicate that at short horizons risk premia are mainly driven by factors related to the funding liquidity, ie the ability to convert assets into cash, of individual banks.

The article is structured in three parts. A first section discusses the possible determinants of the risk premium contained in money market rates and draws tentative conclusions from aggregate data. This is supplemented in a second section by evidence based on the rates quoted by the individual banks contained in the Libor panel. The third section reviews the reaction of interbank rates to bank announcements and central bank actions during the second half of 2007. A final section concludes.

Evidence from aggregate data

Arbitrage arguments suggest that the rates paid on term bank deposits should be closely related to expected overnight rates over the same period of time, since term deposits and revolving overnight deposits are close substitutes. However, this relationship, known as the “expectations hypothesis” of interest rates, need not hold perfectly due to the presence of counterparty credit risk, liquidity factors or a term premium related to the uncertainty about the future path of short-term interest rates. All these factors can drive a wedge between the rates paid on the two types of deposits, which may also fluctuate over time.

Expectations hypothesis of interest rates

Time series on the rates paid by individual banks on their interbank borrowing are notoriously hard to obtain. This is because the interbank market is organised on a bilateral basis, where only the two parties involved in each trade know the precise terms of the transaction. In the absence of comprehensive data on individual transactions, we proxy money market interest rates by the daily Libor fixings published by the British Bankers’ Association (BBA) for a wide range of currencies and maturities. The Libor fixing is meant to capture the rates paid on unsecured interbank deposits at large, internationally active banks. Every day, the BBA surveys a panel of banks, asking them to provide the rates at which they could borrow “reasonable amounts” in a particular currency and maturity at 11:00 GMT. The fact that Libor is based on non-binding quotes, as opposed to actual transactions, may open up the possibility of strategic misrepresentation. The BBA tries to reduce the incentives for such behaviour (and to remove quotes that are untypical for other reasons) by eliminating the highest and lowest quartiles of the distribution and averaging the remaining quotes.²

Interbank rates proxied by Libor fixing

Estimating risk premia in money market rates also requires a measure for expected overnight rates. In the analysis that follows, we use the rates on overnight-indexed swaps (OISs) as a proxy for expected future overnight

Overnight-indexed swaps as measures of interest rate expectations

² See Gyntelberg and Wooldridge in this issue for more details on the fixing mechanism and its implications.

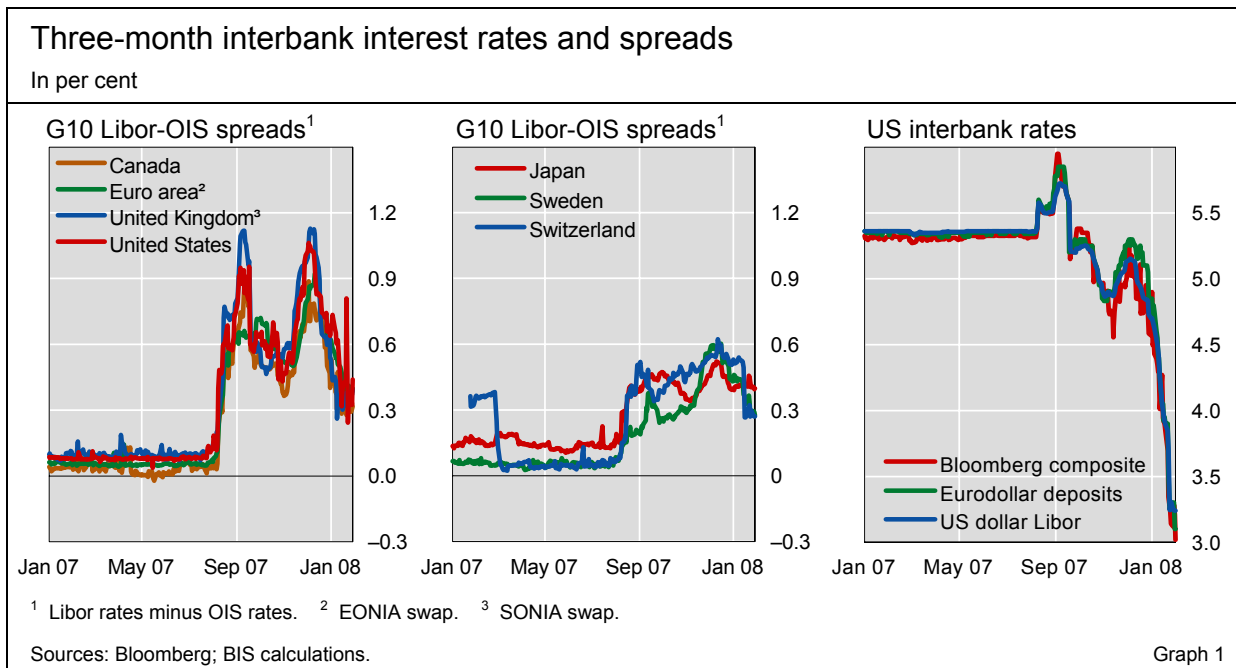
rates.³ We believe that these rates provide a reasonably accurate measure for investors' expectations for two reasons. First, the counterparty risk associated with these contracts is relatively small as they do not involve the exchange of principal; moreover, the residual risk is further mitigated by collateral and netting arrangements. Second, and perhaps more importantly, the liquidity premia contained in OIS rates should be very small as these contracts do not involve any initial cash flows. Under normal market conditions, OIS rates tend to be slightly below the corresponding Libor.

Sharp increase in risk premium ...

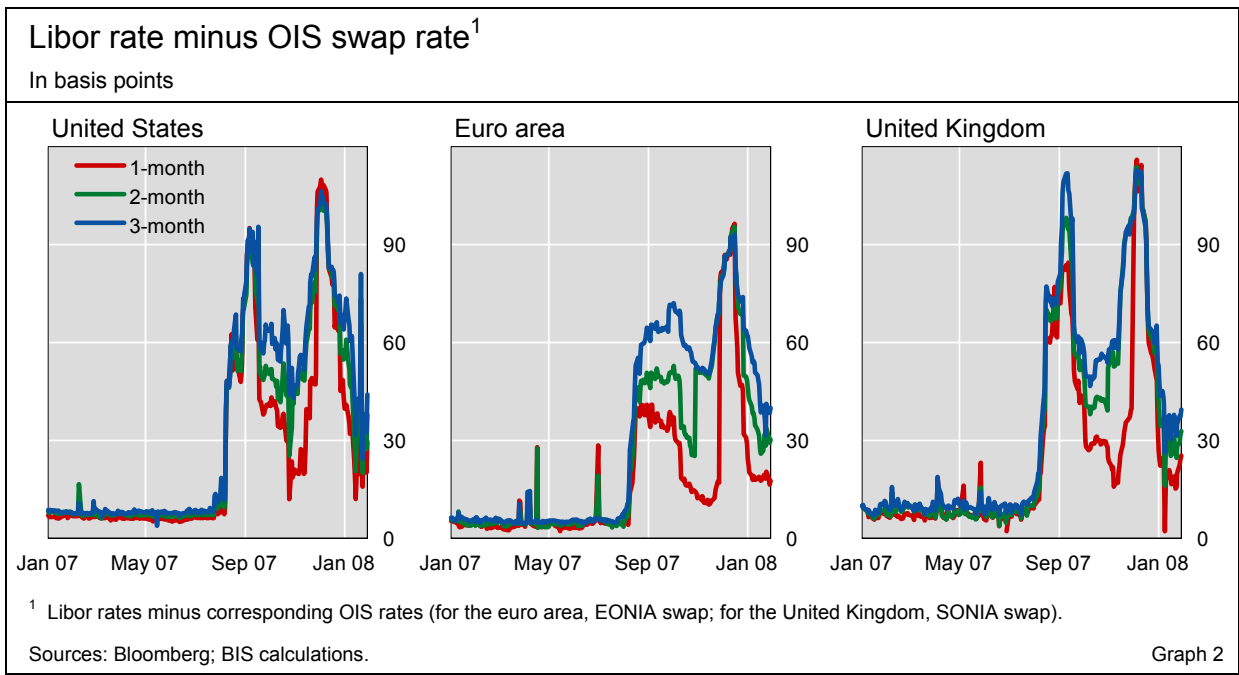
In August 2007, risk premia in short-term money market rates, as represented by the spreads between Libor and OIS rates, increased significantly in most major currencies (Graph 1, left-hand and centre panels). Among the G10 markets, spreads were larger in the Canadian dollar, euro, sterling and US dollar markets. Other non-G10 money markets were much less affected, if at all.

... for deposits at international banks ...

Even at the aggregate level, there is evidence that large, internationally active banks behaved differently during the turmoil than smaller banks whose operations are more focused on the domestic market. In several currencies, the gap between the rates quoted by international banks and domestic money market rates widened noticeably. The impact of large banks' treasury management was perceptible across time zones. In particular, European banks were reported to be bidding rather aggressively in the US dollar market to match their dollar liquidity needs (see Baba, Packer and Nagano in this issue), resulting in specific patterns in the US dollar money market during the morning session. Intraday tensions were also observed in the Australian money market,



³ OISs are interest rate swaps in which the floating leg is linked to a published index of daily overnight rates. The two parties agree to exchange at maturity, on an agreed notional amount, the difference between interest accrued at the agreed fixed rate and interest accrued through the geometric average of the floating index rate.



which is the first to open. The analysis below focuses on large, internationally active banks in the dollar, euro and sterling markets, which were particularly affected by the turmoil.

The developments highlighted in the previous paragraphs were not merely the result of the fixing process used to compute Libor as other measures of three-month interbank interest rates evolved similarly over the same period. This was, for instance, the case with the three-month eurodollar deposit rate and the Bloomberg three-month composite deposit index, which are closer than Libor to prices and rates actually traded (Graph 1, right-hand panel).

The increase in Libor-OIS spreads was particularly large and persistent at the three-month maturity. In September and December, this spread reached levels close to those briefly observed at the end of 1999 in the United States and the euro area due to Y2K concerns. Shorter-maturity spreads initially moved in tandem with three-month spreads in the dollar and sterling markets, but declined well below the latter in late September (Graph 2). The difference between the Libor-OIS spreads across different maturities was even larger in the case of the euro. Two-month spreads in all three currencies shot up at the end of October as their maturity began to extend beyond the end of the year. A month later, an even more pronounced jump was recorded for similar reasons in the one-month maturity, with one-month spreads even exceeding those for longer maturities for a brief period. The differences across maturities and the sudden jumps point to the importance of bank liquidity needs, in particular around the turn of the year, as a driver of Libor-OIS spreads during this period; concerns about counterparty risk would have implied less volatile rates and less variation across maturities.

... particularly at longer maturities

Decomposing the risk premium

The risk premium contained in money market rates can be decomposed into several factors reflecting the characteristics of the borrowing bank as well as

Components of the risk premium

market-wide conditions. Among the bank-specific variables, it is useful to distinguish between the compensation for the risk of default (*credit*) and a premium related to the demand for funds, which depends on the funding liquidity of the borrowing bank (*bliq*). Market-wide conditions include the uncertainty about the path of expected overnight rates, which is reflected in a term premium (*tprem*), the ease of trading (market liquidity *mliq*), and factors related to the fixing process and the microstructure of the market (*micro*):

$$\text{riskpremium} = \text{tprem} + \text{credit} + \text{bliq} + \text{mliq} + \text{micro}$$

Measures for credit risk ...

Disentangling the different components of the risk premium is tricky since there are no financial instruments whose payoffs are directly related to any of the individual factors. In what follows, we proxy banks' risk of default by two different measures: the spread between unsecured and secured interbank rates, and the premium paid on credit default swaps (CDSs) referencing the debt of the borrowing banks. Neither measure is fully satisfactory. Unsecured-secured spreads are affected by a series of liquidity premia, reflecting conditions in the unsecured market, in the secured (repo) market and in the market for the underlying collateral, and there is no reason to believe that these premia offset each other. In particular, if Libor is used as a measure for the unsecured rate, the spread would contain *bliq*, *mliq* and *micro* by construction. Also, safe haven flows during a financial turbulence may drive down rates in the repo market. CDS premia are much less affected by liquidity conditions than the unsecured-secured spread due to our use of benchmark CDSs with a maturity of five years. The main drawback of this measure is, of course, the sizeable maturity mismatch. A final point worth noting is that both unsecured-secured spreads and CDS premia refer to a combination of the risk of default *and* the compensation demanded by investors for bearing this risk, rather than only to the risk of default.⁴

... and market liquidity ...

Data on market liquidity conditions in the money market are not easily available. For the euro money market, we compute indicators for market liquidity from prices and quantities observed on the electronic trading platform e-MID.⁵ There are very few transactions in the three-month segment on e-MID, so we use liquidity in the overnight market as a proxy for liquidity in term deposits.⁶ Since market liquidity in the overnight market appears to have been much less affected by the turmoil than market liquidity in the market for term deposits, the e-MID data are likely to understate the deterioration in liquidity

⁴ There are several measures for credit risk which do not contain a risk premium, but these are generally not available at high frequencies. See Duffie and Singleton (2003) for an overview of credit risk models.

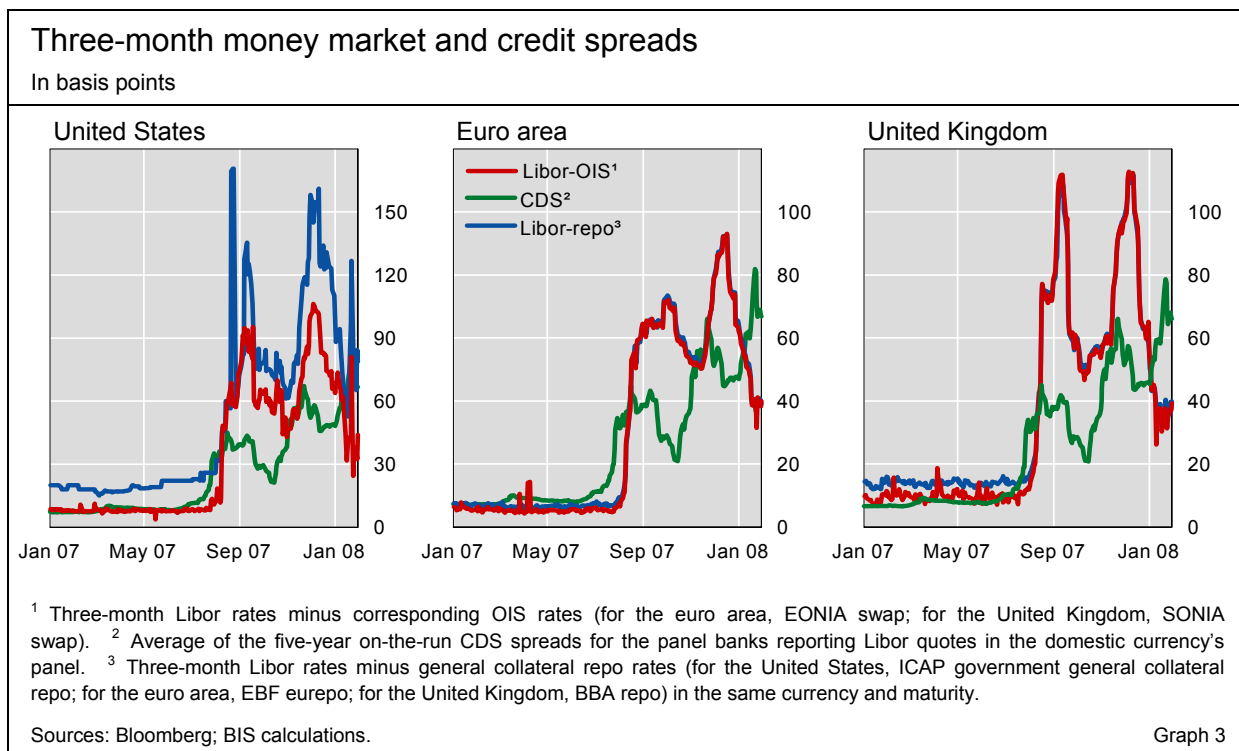
⁵ According to market sources, e-MID had a share of approximately 20% of the unsecured euro money market, although this may have fallen during the turbulence. This decline in market share may affect the reliability of volume-based liquidity indicators but should have less of an impact on price-based measures as long as some market participants are able to arbitrage between the electronic and non-electronic markets.

⁶ Less than 1% of all transactions on e-MID have a maturity of three months, while almost 80% are overnight loans.

conditions in the term market during the second half of 2007. That said, they may still provide useful information on *when* market liquidity was impaired, even if they understate the extent of the problems. The various dimensions of market liquidity are captured by the number of trades, volume, bid-ask spreads,⁷ and the price impact of a trade.⁸ In order to ensure exogeneity, all measures are computed for the time from market opening until 10:50 GMT, ie 10 minutes before the Libor fixing.

Measurement problems are greatest when it comes to assessing bank-specific funding liquidity and microstructure effects. Relevant information for assessing the funding liquidity of Libor banks would include liquidity ratios and the size of potential commitments. Unfortunately, these variables are not available on a systematic basis at a relevant frequency.⁹ We therefore treat *bliq* (and *micro*) as an unobserved variable whose effects will appear as a residual once the impact of all other variables has been taken into account.¹⁰ If funding liquidity deteriorated around the same time as our measures for credit risk, then treating *bliq* as an unobserved variable may result in us attributing too much of the variation in risk premia to credit factors. Indeed, there are at

... but not on banks' funding liquidity positions



⁷ Effective spreads are computed from transaction data using the Roll (1984) approach.

⁸ A daily series for the price impact of a transaction is obtained by regressing price changes over a five-minute interval on signed volumes during that interval. The coefficient on signed volumes corresponds to the price impact.

⁹ Ashcraft and Bleakley (2006) use shocks to daily reserve balances of US banks in order to control for funding liquidity. Similar data do not exist on an international basis.

¹⁰ A similar approach has been taken by Bank of England (2007), who calculate a credit premium from CDS premia and refer to the residual as the non-credit premium.

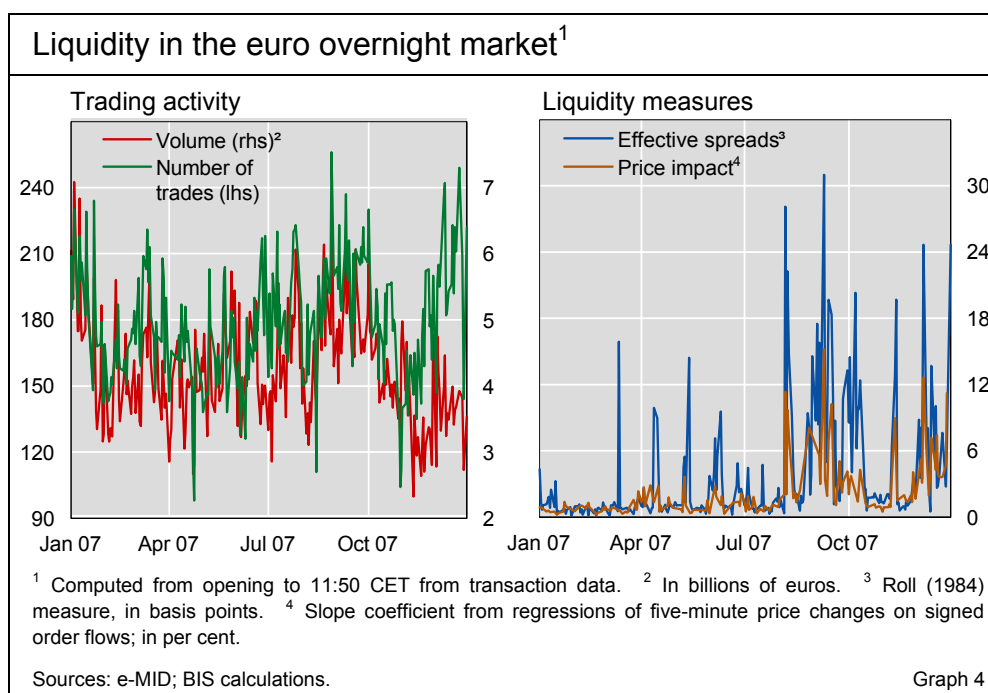
Libor-OIS spreads
co-move with
measures for credit
risk

least two reasons why our measures for credit risk might be related to banks' funding liquidity. First, banks may hoard liquidity in times of high systematic risk. Second, they may default for liquidity as well as for solvency reasons.

A comparison of the aggregate series suggests that both indicators for credit risk track Libor-OIS spreads reasonably well during the second half of 2007. In the second half of 2007, unsecured-secured spreads were almost identical to Libor-OIS spreads in the euro and sterling market (Graph 3), or even above them in the dollar market, perhaps reflecting the fact that both indicators are driven by the same liquidity premia. This is in sharp contrast to the situation in late 1999, when concerns about liquidity around the turn of the millennium drove up the spread between Libor and policy rates¹¹ but hardly moved credit risk indicators. This suggests that, compared with that episode, credit concerns might have played a significantly larger role in the current episode.

However, the relationship between CDS premia and Libor-OIS spreads is much less close than that between Libor-OIS spreads and the unsecured-secured spread. If anything, CDS premia lead Libor-OIS spreads in all three currencies during the second half of 2007. For example, CDS premia on the Libor banks began to rise in late July, almost two weeks before Libor-OIS spreads went up. A similar leading relationship is apparent for the temporary decline in Libor-OIS spreads in October and the rise towards the end of the year. The relationship between Libor-OIS spreads and CDS premia breaks down in January 2008, when the risk premium in the money market declined whereas CDS premia shot up.

There are at least two potential explanations for the relatively loose relationship between Libor-OIS spreads and CDS premia. First, it could be due



¹¹ OISs either did not exist or were not actively traded at the time.

to the different maturities of the two indicators. While it is impossible to dismiss this hypothesis, it cannot explain the fact that CDS premia lead Libor-OIS spreads. Second, and probably more realistically, it points to the importance of liquidity factors (*bliq* and *mliq*). For example, the relatively wide gap between euro Libor-OIS spreads and CDS premia in August and September is consistent with the evolution of the market liquidity in the euro overnight market (Graph 4), where both effective bid-ask spreads and the measure for the price impact of a trade executed on the e-MID platform increased sharply during the same period. Similarly, the differences across maturities of Libor-OIS spreads driven by concerns about banks' funding liquidity around the turn of the year (see above) are also consistent with this hypothesis.

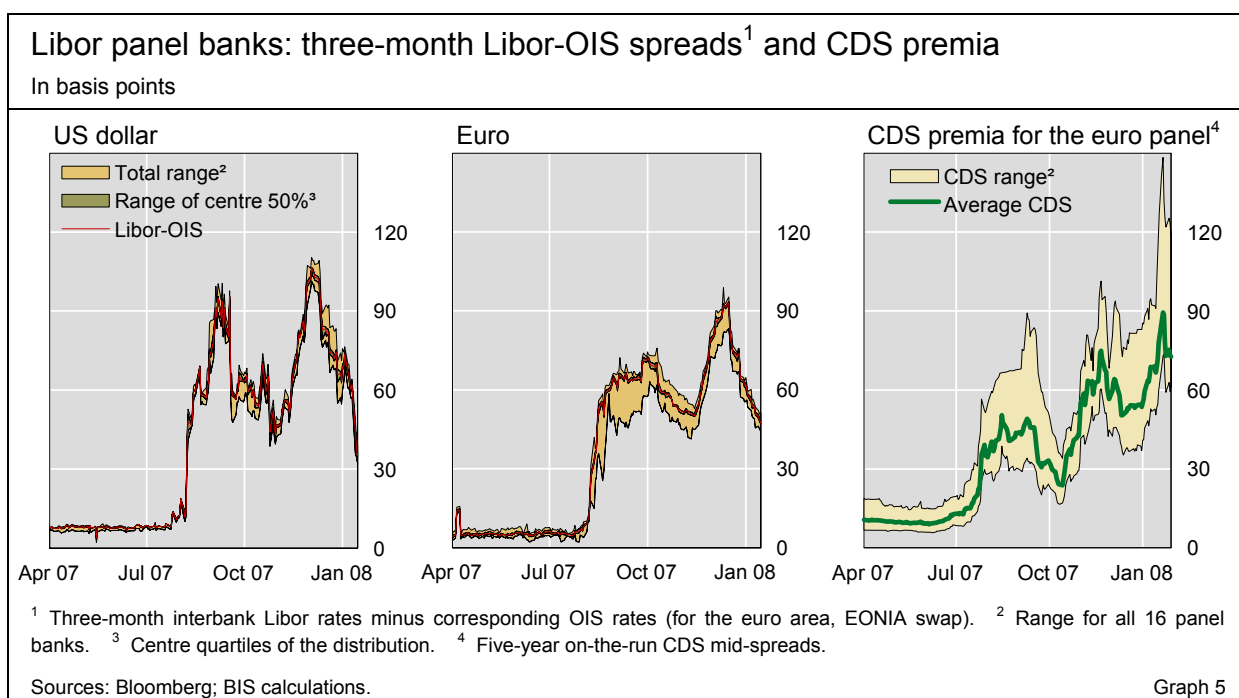
Evidence from panel data

While Libor-OIS spreads increased for all banks in the second half of 2007, the extent of the increase clearly varied across markets and institutions. In the euro money market (Graph 5, centre panel), the dispersion in quoted rates was more pronounced than in the dollar (left-hand panel) or sterling (not shown). However, even in the euro area the dispersion was, at least initially, driven by a small number of banks quoting relatively low rates in their responses to the Libor panel. The interquartile range, from which Libor is calculated, was extremely narrow in all three currencies, rarely exceeding 2 basis points even at the height of the turmoil. This contrasts with anecdotal evidence gathered from conversation with market participants, who argued that the rates quoted and paid by banks on their interbank borrowing tended to vary more than usual (and by more than what appears in the Libor panel) during the turbulence.

The fairly low degree of dispersion of Libor quotes compared with the dispersion of their CDS premia (right-hand panel) suggests that banks' quoting

Marked differences across banks

Little evidence for credit factors affecting quoting behaviour ...



behaviour in the interbank market reflected only to a small extent, if at all, any risk of default. This first impression is confirmed by econometric evidence. Regressing daily cross sections of three-month Libor-OIS spreads on the cross section of CDS premia¹² yields a coefficient that is both economically and statistically insignificant in all three currencies. This indicates that banks with higher CDS premia do not appear to have quoted significantly higher rates on a given day than banks with lower credit risk.

... except perhaps
in the long run

Similar econometric evidence suggests that while credit factors may have influenced the longer-term movements in Libor-OIS spreads, they do not appear to have had much of an effect on their day-to-day variations. Specifically, a panel estimation of Libor-OIS spreads on CDS premia points towards the existence of a long-term equilibrium (cointegrating) relationship between the two variables in all three currencies, even as day-to-day changes in CDS premia have little explanatory power for those in Libor-OIS spreads. Experimenting with a large number of specifications at daily and weekly frequencies shows that it takes a long time for changes in CDS premia to feed into Libor-OIS spreads.¹³

While useful, the above econometric evidence should be interpreted with considerable caution. For one, it is vulnerable to the omitted variable bias noted above. In addition, even the evidence of a long-term relationship between credit and Libor-OIS spreads could be picking up the effect of structural breaks in the sample, at the time the turmoil erupted.

Evidence from event analysis

Price reactions to
bank losses and
central bank
emergency
liquidity ...

Additional information on the respective roles of credit and liquidity factors as determinants of Libor-OIS spreads can be obtained from reviewing the impact on spreads of news related to credit quality and liquidity conditions. For example, announcements of large writedowns, losses or the support to off-balance sheet vehicles by individual banks have been interpreted by many observers as providing information on the credit quality also of other banks. Similarly, extraordinary liquidity provision by central banks has led to large changes in the funding liquidity of banks, at least temporarily. Neither type of event is easily included in regression analysis, since both tend to occur on an irregular basis and their impact is not readily quantifiable except by looking at market reactions in various segments.

This section is based on the responses of Libor-OIS spreads in the three currencies, CDS premia and equity prices of the panel banks to 20 events, one half bank announcements, the other half central bank actions.¹⁴ If

¹² Secured-unsecured spreads are not available for individual banks.

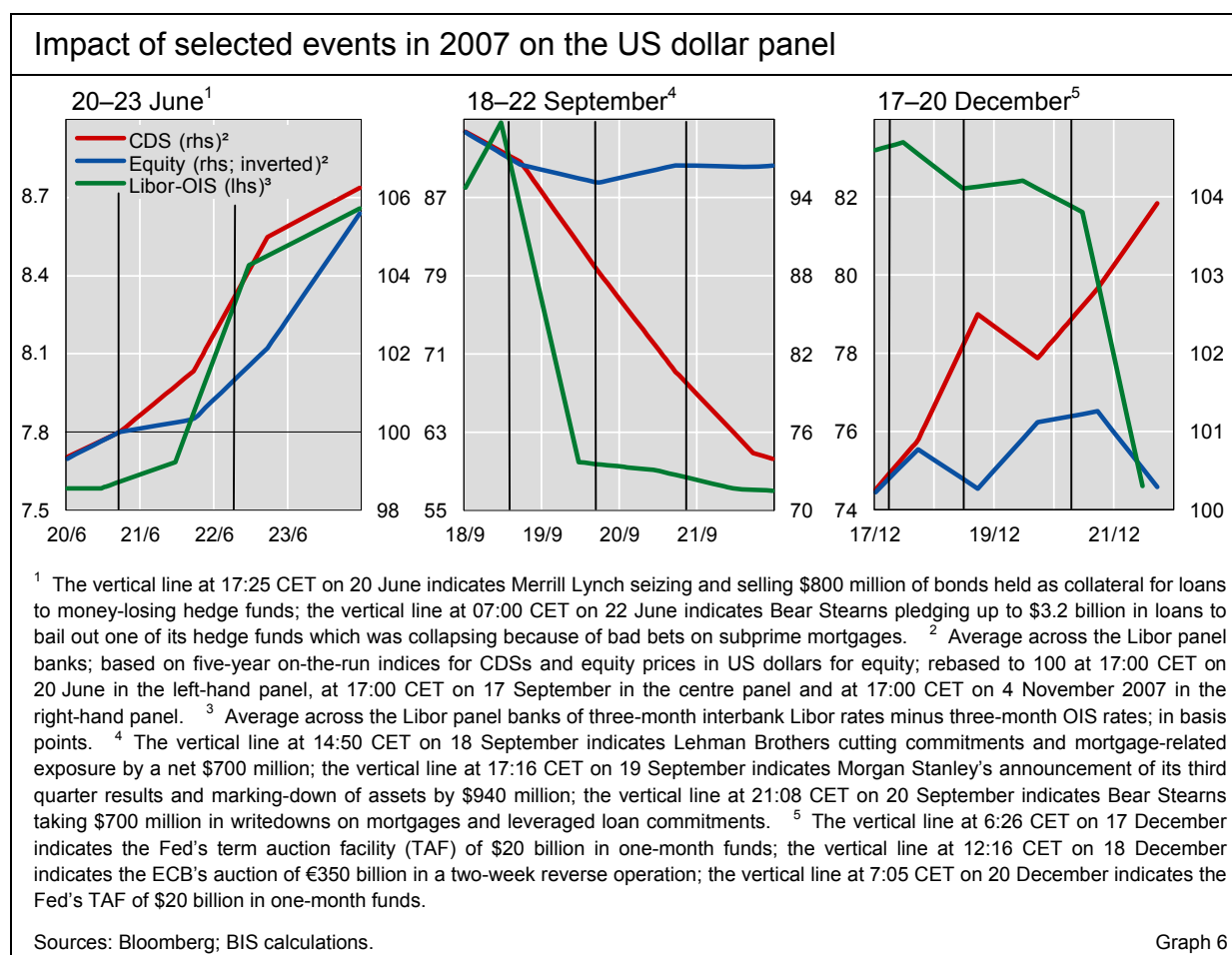
¹³ As a consequence, a large number of lags is needed to capture the dynamics of adjustment, with the corresponding risk of overfitting the data. Moving to a lower frequency does not solve the problem, since the number of lags becomes very large relative to the estimation period even when weekly data are used.

¹⁴ Central bank extraordinary liquidity management operations were aimed at helping banks manage their liquidity needs. It is worth noting that the total outstanding amount of reserve

unanticipated, both types of events can be expected to affect Libor-OIS spreads. While bank announcements of unanticipated writedowns or similar events might be expected to drive up both Libor-OIS spreads and CDS premia, the effect of central bank actions is less clear-cut: the provision of additional liquidity should drive down Libor-OIS spreads but not necessarily CDS premia. Provisions of central bank liquidity should reduce CDS premia only if market participants fear that banks may default due to liquidity problems; otherwise their expected impact on measures of credit risk is not obvious.

The effects of the events on market prices were surprisingly diverse across events and over time (see examples for the US dollar panel in Graph 6). Only six out of the 10 bank announcements resulted in higher Libor-OIS spreads, and five in higher CDS premia. For example, the announcement by Bear Stearns that it had pledged up to \$3.2 billion in loans to bail out one of its hedge funds on 22 June led to an increase in both Libor-OIS spreads and CDS premia. Similarly, Citigroup's disclosure of large subprime-related exposures and the retirement of its CEO on 4 November also caused Libor-OIS spreads and CDS premia to rise and equity prices to fall. By contrast, the announcement on 20 September by Bear Stearns of a \$700 million writedown on mortgage and leveraged loan commitments was associated with a decline in

... vary over time



transactions at large central banks has remained stable overall since August 2007. In other words, liquidity provision by central banks did not replace interbank borrowing, except perhaps for short periods of time.

CDS premia and Libor-OIS spreads and had no apparent impact on share prices. CDS premia declined in three other cases concentrated between the end of September and beginning of December, possibly reflecting some relief on the part of market participants after the announcement of third quarter results by several US investment banks and additional official support to Northern Rock.

As expected, the 10 central bank extraordinary liquidity management operations appear to have had a clear-cut impact on Libor-OIS spreads but not on CDS premia. Libor-OIS spreads declined in seven out of the 10 cases, with the largest effects being felt in the central banks' own currency. CDS premia fell in only five cases. One of the central bank measures consisted in three consecutive auctions of overnight repurchase agreements by the Federal Reserve on 10 August. It led to declines in both US dollar and euro Libor-OIS spreads, as well as to lower CDS premia and higher share prices for the banks in the two (largely overlapping) panels.¹⁵

Overall, the reaction of asset prices to the 20 events gives support to the notion that both credit and liquidity risk played a role in explaining the high level of the three-month risk premium in the second half of 2007, although the evidence is stronger in the case of the liquidity factors. However, this may in part be due to a general shortcoming in the methodology used, since we cannot be sure that the bank announcements were always considered as bad news by market participants. For example, investors may interpret the announcement of losses as banks actually recognising and addressing problems that had been virulent for some time.¹⁶

Concluding thoughts

This feature offers some evidence on the importance of credit and liquidity factors for the rates paid in the interbank market during the recent financial turmoil. However, the results are still preliminary and subject to a longer than usual list of caveats for a variety of reasons. First, the turbulence was still unfolding at the time of writing, despite significant improvements in money market conditions. New data will invariably offer new insights, which may cause us to revise some of the conclusions drawn at this early stage. Second, a central variable of interest, namely bank-specific funding liquidity, cannot be observed and is therefore treated as a residual. Since funding liquidity may be related to our measures of credit risk, this may result in too much of the

¹⁵ While it is not part of the list of events, it is also worth noting that the decision by the Federal Open Market Committee to lower its target for the federal funds rate by 50 basis points to 4.75% on 18 September resulted in lower Libor-OIS spreads and CDS premia and higher equity prices across all three currencies and various maturities.

¹⁶ Interestingly, Libor-OIS spreads, CDS premia and equity prices did not appear to move more synchronously within the event windows than they did outside them. Reactions across asset classes following bank announcements and central bank operations were consistent in only five and four out of the 10 cases, respectively. This, as well as the mixed responses of CDS premia, may reflect other factors, such as investors' overall risk appetite at a given point in time, lags in market reactions or different investor classes across market segments.

variation in the risk premium being attributed to credit factors. Third, there may be a problem with using quotes rather than actual transaction data.

With all these caveats in mind, our results support the view that both credit and liquidity factors were behind the increase in risk premia in the interbank money market. The role of credit factors is more easily traceable at lower frequencies. Evidence from aggregate data, panel regressions and event studies show that, at higher frequencies, bank-specific funding liquidity needs have played a more important role. Finally, in the cross section, we do not find systematic evidence that banks with higher perceived credit risk quoted higher Libor rates than their peers on a given day.

References

Ashcraft, A and H Bleakley (2006): "On the market discipline of informationally opaque firms: evidence from bank borrowers in the federal funds market", Federal Reserve Bank of New York, *Staff Report*, no 257.

Bank of England (2007): "An indicative decomposition of Libor spreads", *Quarterly Bulletin*, fourth quarter, pp 498–99.

Duffie, D and K Singleton (2003): *Credit risk: pricing, measurement, and management*, Princeton University Press.

Markets Committee (2007): *Monetary policy frameworks and central bank market operations*, Bank for International Settlements, December.

Roll, R (1984): "A simple implicit measure of the effective bid-ask spread in an efficient market", *Journal of Finance*, 39, pp 1127–40.