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Key Words: Liquidity Shocks; Monetary Policy; Market Micro-Structure; Stock Returns.

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Abstract

This study examines the impact of macro-liquidity shocks on the returns of UK stock portfolios sorted on the basis of a series of micro-liquidity measures. The macro-liquidity shocks are extracted on the meeting days of the Bank of England Monetary Policy Committee relative to market expectations embedded in futures contracts on the 3-month LIBOR during the period June 1999- December 2009. We report definitive evidence that these shocks are transmitted to the cross-section of liquidity-sorted portfolios, with most liquid stocks playing a very active role. Our results emphatically document that the shocks-returns relationship has reversed its sign during the recent financial crisis; the standard inverse relationship between interest rate surprises and portfolios' returns *before* the crisis has turned into positive *during* the crisis. This finding confirms the inability of interest rate cuts to boost returns in the short-run *during* the crisis, because these were perceived by market participants as a signal of a deteriorating economic outlook.

1. Introduction

The recent global financial crisis has highlighted the importance of liquidity for the well-functioning of financial markets. It is now well understood that a decline or, at worst, evaporation of liquidity may cause large falls in asset prices that are not justified by their fundamentals. It may also cause the initialization of a downward spiral in asset prices, amplified by fire sales and deleveraging to meet margin calls and higher haircuts (see Brunnermeier, 2009, and Gorton and Metrick, 2010b). Such feedback mechanisms can eventually pose a major threat to the stability of the financial system (Pedersen, 2009). Liquidity plays a crucial role both at the macro level and at the micro level. Macro-liquidity mainly refers to the money supply provision by central banks and the availability of funds for financial markets' participants, such as financial intermediaries. Micro-liquidity mainly refers to the trading conditions of individual assets, namely the cost, speed, volume and price impact of transforming cash into financial assets and vice versa (Chordia, Sarkar and Subrahmanyam, 2005). The aim of this study is to examine the potential link between liquidity at a macro and a micro-level by evaluating the response of liquidity-sorted stock portfolios' returns to macro-liquidity shocks on the Bank of England (BoE) Monetary Policy Committee's (MPC) meeting days over the period June 1999- December 2009.

Central banks are considered to be the primary suppliers of funds in the economic system. Managing inflation expectations, enhancing growth and employment prospects as well as preserving the stability of the financial system are typically the mandates of central bank authorities. To this end, they possess a set of monetary policy tools for managing macro-liquidity. The policy rate they determine is considered to be the benchmark for the term structure of interest rates. This is particularly true for the short-end of the yield curve (Kuttner, 2001). Moreover, the terms of liquidity provision to financial intermediaries affect to a great extent the broad money supply in the economy. It has been well documented how the credit channel of the monetary policy transmission mechanism affects firms' operations and the entire economy as a result (see *inter alia* Fazzari, Hubbard and Petersen, 1988, Bernanke and Gertler, 1989, Bernanke and Blinder, 1992, and Bernanke and Gertler, 1995). Crucially for the focus of our study, the pivotal role of intermediaries in the modern financial system also implies that macro-liquidity shocks induced by changes in the monetary policy stance of central banks can be transmitted through the entire intermediation chain, eventually affecting institutional and individual investors in the marketplace.[1]

Most obviously, the interbank market is crucially affected by monetary policy decisions; these are reflected in LIBOR fluctuations that influence the flow of funds among major intermediaries and determine the value of their proprietary portfolio of assets and agreements as well as the borrowing ability of dealers (see Garcia, 1989, for an account of the monetary policy tools for liquidity provision to intermediaries). As a result, these intermediaries may have to rebalance their own portfolios and modify their risk exposure and degree of leverage to meet regulatory requirements and remain solvent. Adrian and Shin (2010a) convincingly demonstrate that investment banks had been actively managing their leverage as a response to changes in their balance sheets' size. Reinforcing this argument, Kashyap and Stein (2000) provide evidence that the transmission of liquidity shocks via banks depends, in the first place, on the composition and quality of their own balance sheets. Gromb and Vayanos (2002) show that shifts in market liquidity can lead to significant losses in the positions of financially constrained intermediaries, who in turn may exacerbate asset prices' volatility and become unable to exploit arbitrage opportunities. Such liquidity shocks may actually cause cross-market contagion effects (Gromb and Vayanos, 2009).

At the same time, intermediaries pass on to their institutional or individual clients these new terms of funds' exchange by modifying their lending standards as well as their margin requirements or call rates, which in turn may cause major shifts in the composition of these clients' portfolios and the trading conditions for the corresponding financial assets. Brunnermeier and Pedersen (2009) model the interaction between the availability of funds for traders and microstructure liquidity in asset markets. Fortune (2000) explains the mechanics of margin lending and demonstrates the close relationship between the broker call money rate and the Fed Funds rate. In a recent study related to ours, Nyborg and Ostberg (2010) analyze the various processes through which banks attempt to recover liquidity (collectively termed "liquidity pull-back") when they face tighter funding conditions. Gromb and Vayanos (2010) model how the level of capital available to financially constrained intermediaries affects market liquidity. In sum, a shift in the quantity of available funds and the price of liquidity at the macro-level due to monetary policy actions can be spread along the intermediation chain, reaching investors and traders by altering their funding conditions and investment decisions; this alteration will be eventually manifested through shifts in microstructure liquidity.

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[1] Adrian and Shin (2010b) provide a detailed description of the long intermediation chain characterizing a modern financial system and the transmission of liquidity shocks across its links.

There is an extensive literature documenting the impact of monetary policy shocks on stock returns using various approaches for the identification of these shocks. Jensen and Johnson (1995) suggested a dummy variable approach to distinguish between expansionary and contractionary monetary policy regimes. Thorbecke (1997) put forward a VAR approach to identify such shocks and computed the corresponding impulse responses of stock returns, while Bernanke and Kuttner (2005) used the methodology suggested by Kuttner (2001) to extract a measure of “surprise” rate changes from futures contracts written on the Fed Funds rate.[2] The latter approach has become quite popular in the literature, because these futures contracts naturally embed market participants’ expectations in a very successful way (see Gurkaynak, Sack and Swanson, 2007, for a comparison of various market instruments’ forecasting ability over future monetary policy), and hence one-day changes in their prices more cleanly isolate the unanticipated element of policy actions (shock). Moreover, as Piazzesi and Swanson (2008) note, measuring shocks through one-day futures price changes is a robust approach because low-frequency risk premia that are potentially incorporated in futures prices are effectively “differenced out”.

This event study methodology has been also applied to international stock markets (see Wongswan, 2009 and Bredin, Hyde, Nitzsche and O’Reilly, 2009) as well as bond markets (see Bredin, Hyde and O’Reilly, 2010). For the UK market, which is the focus of our study, Bredin, Hyde, Nitzsche and O’ Reilly (2007) have examined along the same lines the impact of anticipated and unanticipated interest rate changes on FTSE and sectoral returns on meeting days of the BoE’s MPC. Similar is the approach of Gregoriou, Kontonikas, MacDonald and Montagnoli (2009) for a more recent period. For the UK, however, there are no futures market instruments that track the BoE’s policy rate (the two week repo rate). The closest substitute that these studies employ is the 3-month Sterling LIBOR futures contract traded on LIFFE. This is one of the instruments used by BoE to gauge market expectations regarding future interest rates (Brooke, Cooper and Scholtes, 2000, Joyce, Relleen and Sorensen, 2008). Since these futures contracts are actually written on LIBOR, we argue that the changes of their prices on MPC meetings days can be more broadly considered as macro-liquidity shocks initiated by the central bank actions (or inactions) rather than being narrowly

[2] Fleming and Remolona (1997), Lobo (2002), Piazzesi (2005) and Laopodis (2006) have also documented the impact of monetary policy shocks on stock and bond market returns. A series of other studies have examined this issue using the cross-section of stock returns; Jensen, Johnson and Mercer (1997), Guo (2004), Maio and Tavares (2007) studied the response of size and value portfolios’ returns, while Ehrmann and Fratzscher (2004) and Basistha and Kurov (2008) utilized portfolios of financially constrained stocks.

defined as monetary policy shocks. This is especially true because the LIBOR is not necessarily equal to the BoE's policy rate; their spread, equivalent to the LIBOR-OIS spread in the US, is actually time-varying and conveys significant information for the interbank market conditions in periods of liquidity draughts (Gorton and Metrick, 2010a,b).

To examine the potential link between macro- and micro-liquidity, we utilize this event study methodology to assess the impact of macro-liquidity shocks on the returns of stock portfolios that have been formed on the basis of a series of liquidity measures. Even though traditional asset pricing models assume perfect capital markets, it is now well understood that micro-structure liquidity is an important source of market frictions and it can have first-order effects on asset prices (see the seminal studies of Amihud and Mendelson, 1980, 1986a, 1986b). Most importantly, there is sufficient evidence that micro-structure liquidity can be regarded as a risk factor leading to substantial risk premia in the cross-section of stock returns (Pastor and Stambaugh, 2003; Acharya and Pedersen, 2005). Motivated by this evidence, we argue that macro-liquidity shocks, to the extent that they affect the microstructure liquidity conditions in the stock market, may also have a differential impact on the cross-section of liquidity-sorted portfolios' returns. Stocks with different microstructure characteristics, and hence different exposure to micro-liquidity risk, may be differently affected by a common macro-liquidity shock.

Despite the considerable attention that micro-liquidity measurement has attracted in prior literature, it remains an elusive concept (Amihud, 2002; Pastor and Stambaugh, 2003). This feature has led to the emergence of a vast literature proposing a series of measures capturing the four dimensions of liquidity (trading cost, quantity, speed and price impact). Our aim is to provide comprehensive evidence on the examined link, and hence we construct and utilize stock portfolios on the basis of six measures, covering every dimension of micro-liquidity. In particular, we utilize the universe of stocks listed on the London Stock Exchange (LSE) during the period 1999-2009 and we construct decile portfolios by ranking them according to their bid-ask spread (Amihud and Mendelson, 1986a), relative spread (Amihud and Mendelson, 1986b, Loderer and Roth, 2005), turnover rate (Datar, Naik and Radcliffe, 1998, Chordia, Subrahmanyam, Anshuman, 2001), trading volume (Brennan, Chordia and Subrahmanyam, 1998), Return-to-Volume (RtoV) price impact ratio (Amihud, 2002) and Return-to-Turnover Rate (RtoTR) price impact ratio (Florackis, Gregoriou and Kostakis, 2009).

The study most related to ours is the recent contribution by Nyborg and Ostberg (2010). They examine the link between liquidity in the interbank market and trading conditions in the

US stock market utilizing a long time series of daily observations. In particular, they examine whether the LIBOR-OIS spread affects differentially the trading volume and the returns in the cross-section of liquidity-sorted portfolios; they use Amihud's (2002) RtoV measure to rank stocks and construct decile portfolios.[3] In the same spirit, Fernandez- Amador, Gachter, Larch and Peter (2010) use a VAR framework to examine the impact of ECB monetary policy stance on the micro-liquidity of three major Eurozone markets. Instead, our focus is mainly on the response of liquidity-sorted portfolios in terms of returns using a plethora of measures. Our study is also related to the seminal paper of Chordia, Sarkar and Subrahmanyam (2005), who were the first to establish a link between macro and micro-liquidity. They estimated VAR systems to calculate impulse responses of a series of microstructure features and returns in the stock and bond market to unanticipated changes in the Fed Funds rate, net borrowed returns, equity and bond mutual fund flows. Our approach to utilize the cross-section of liquidity-sorted portfolios, rather than broad stock market or sectoral indices can shed more light to this link.

Previewing our empirical results we highlight the following main findings. First, there has been a structural break in the relationship between macro-liquidity shocks and liquidity-sorted portfolio returns *during* the recent crisis period. Failing to account for this break, one would erroneously conclude that macro-liquidity shocks have no effect on returns. Second, these shocks are transmitted to the cross-section of liquidity-sorted portfolios but in a differential manner between the most liquid and the most illiquid portfolios. Interestingly, the effect is much more statistically and economically significant for the most liquid portfolios. Third, the commonly documented inverse relationship between interest rate surprises and returns *before* the crisis has reversed its sign *during* the crisis. Interest rate cuts *during* the crisis not only failed to boost returns in the short-run, but they actually led liquid stocks to lower prices, because these were perceived by stock market participants as a signal of a worse economic outlook by the Bank of England.

Our study is structured as follows. Section 2 describes the employed dataset and discusses various methodological issues. Section 3 contains the benchmark results, examining the impact of macro-liquidity shocks on liquidity-sorted stock portfolios. Section 4 contains a

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[3] The LIBOR-OIS spread is widely accepted as "a barometer of fears of bank insolvency" in the words of Alan Greenspan (see Thornton, 2009 and Gorton and Metrick, 2010a for an analysis of its features). Following Nyborg and Ostberg (2010), we also consider daily changes in the LIBOR-BoE base rate spread on MPC meeting days as an alternative measure of macro-liquidity shocks, complementing our benchmark results based on shocks implied by the LIBOR futures contracts.

series of robustness tests, utilizing also an alternative measure of liquidity shock, while Section 5 concludes.

2. Data and Methodology

In line with the methodology suggested by Kuttner (2001), we use data from interest rate futures to extract macro-liquidity shocks on BoE's MPC meeting days. Following Fed's practice, MPC meeting days' schedule has become publicly known since June 1997.[4] As mentioned in the Introduction, there is no futures contract written on BoE's policy rate, the two-week repo rate. The most appropriate substitute is the short sterling futures contract that settles on the 3-month British Bankers' Association (BBA) London Interbank Offer Rate (LIBOR) prevailing at 11:00 on the last trading day (third Wednesday of the delivery month). The settlement price is 100 minus the BBA LIBOR rounded to three decimal places. Contracts are standardised and traded between members of the London International Financial Futures and Options Exchange (LIFFE). This futures contract is widely used to hedge against and speculate on future interest rate movements, and hence it is well regarded to accurately embed market expectations (see Brook et al., 2000, and Bredin et al., 2007). Therefore, the *unanticipated* (unexpected) interest rate shock, Δi_d^u, is defined as the change in the implied 3-month LIBOR rate on the MPC meeting day, *d*, relative to the previous day, *d-1*, i.e.:

$$\Delta i_d^u = f_{m,d} - f_{m,d-1} \tag{1}$$

where $f_{m,d}$ is the implied interest rate, 100 minus the LIFFE futures contract price, extracted by the corresponding contract with delivery month *m* nearest to the MPC meeting day *d*.[5] The sample period under investigation is June 1999-December 2009, a total of 128 MPC meetings.[6] Moreover, we define the *anticipated* (expected) change in interest rate, Δi_d^e, as the actual change in the 3-month LIBOR rate minus the *unanticipated* change:

[4] The list of meetings and decisions is available at http://www.bankofengland.co.uk/monetarypolicy.

[5] No adjustment is necessary for the number of days remaining in the month as in the US studies, because unlike the futures on the Fed funds rate whose settlement is based on the *average* Fed funds rate of the last month in the futures' life, in the UK the settlement of the 3-month LIBOR futures is based on the corresponding LIBOR of the last trading day.

[6] We start our event study analysis from June 1999 because LIBOR futures contracts did not settle on a monthly basis before that date; only contracts with quarterly delivery existed. The lack of

$$\Delta i_d^e = \Delta i_d - \Delta i_d^u \tag{2}$$

For the construction of liquidity-sorted portfolios, we consider an initial sample that consists of all common stocks listed on the London Stock Exchange for the period from May 1999 to December 2009. Our analysis covers both presently listed and dead stocks (i.e. stocks of firms that were de-listed at some point during the sample period), and hence our dataset is free of any potential survivorship bias. We minimize the impact of outliers by excluding stocks with a very low market value or a temporary listing period. Moreover, we also exclude stocks with less than 15 trading days in each month. Finally, following conventional practice in UK stock market studies (see e.g. Fletcher and Kihanda, 2005), we exclude unit trusts, investment trusts and ADRs. Our final dataset comprises of an average of 933 stocks in each month.

We obtain data from Thomson DataStream and construct, on a daily basis, a series of micro-structure measures, namely bid-ask spread, relative spread, turnover, volume, return to volume and return to turnover, which capture different dimensions of liquidity (i.e. trading cost, trading quantity, trading speed and price-impact). We define *bid-ask spread* as the pound difference between the ask price quoted (PA) and the bid price offered (PB) at the close of the market. *Relative spread* is the bid-ask spread divided by the mid-price, where the mid-price is given by (PA+PB)/2. *Turnover* is the ratio of number of shares traded on a day to the number of shares outstanding on that day. *Volume* is measured as the total value (in sterling pounds) of all shares traded for a stock on a particular day. *Return-to-Volume* (RtoV) represents the price impact ratio for each stock and is calculated as the monthly average ratio of the absolute daily return to the corresponding pound trading volume. Formally, this is given by:

$$RtoV_{im} = \frac{1}{D_{im}} \sum_{d=1}^{D_{im}} \frac{|R_{imd}|}{V_{imd}} \tag{3}$$

where R_{imd} and V_{imd} are, respectively, the return and monetary volume of stock i on day d at month m and D_{im} is the number of valid observation days in month m for stock i. Finally, *Return-to-Turnover Rate* (RtoTR) is an alternative price impact ratio for each stock and is

correspondence in frequencies between the event (MPC monthly meetings) and the instrument's settlement may lead to biased estimates of the shock before June 1999.

calculated as the monthly average ratio of the absolute daily return to the corresponding turnover rate.[7] This is given by:

$$RtoTR_{im} = \frac{1}{D_{im}} \sum_{d=1}^{D_{im}} \frac{\left|R_{imd}\right|}{TR_{imd}} \qquad (4)$$

where TR_{imd} is the Turnover Rate of stock *i* at day *d*, while D_{im} and R_{imd} are as previously defined.

For each of these liquidity measures, we sort listed stocks on a monthly basis and we construct decile portfolios (P1 to P10). Portfolio 1 (P1) contains the most liquid stocks while Portfolio 10 (P10) contains the most illiquid stocks. Portfolios are rebalanced on a monthly basis to incorporate the latest available information. Since we are interested in the portfolios' return response due to a macro-liquidity shock on the MPC meeting days, we calculate (daily) value-weighted decile portfolio returns on every meeting day *d* of month *m* for each micro-liquidity measure; these decile portfolios have been constructed on the basis of the liquidity measures' values at the end of month *m-1*, i.e. the latest publicly available information. Panel A of Table 1 contains descriptive statistics for the returns of the most liquid and most illiquid portfolios, respectively, on the MPC meeting days. Panel B presents the corresponding pairwise correlation coefficients of the portfolios' returns. As expected, these daily returns are highly correlated, confirming that there is a degree commonality among these popular liquidity measures. However, these correlations are less than perfect for most of the cases, especially for the most illiquid portfolios, showing that each measure captures different elements of micro-liquidity. This finding confirms that it is worth considering all these measures in an attempt to provide comprehensive evidence on the response of micro-liquidity sorted portfolios' returns to macro-liquidity shocks.

[Table 1 about here]

3. Empirical results

[7] The latter price impact ratio is motivated by the potential cross-sectional size bias that Amihud's *RtoV* ratio encompasses. In particular, since trading volume, appearing in the denominator of this ratio, is highly correlated with stocks' market value, ranking stocks according to *RtoV* is almost identical to ranking them according to their capitalization (see Florackis, Gregoriou and Kostakis, 2009 for a more detailed analysis). On the other hand, *RtoTR* is not expected to exhibit a size pattern, because turnover rates are not strongly correlated with market values.

The starting point of our analysis is to examine, for the sample period considered, the relationship between expected and unexpected interest rate changes and stock returns on the BoE MPC meeting days using the portfolios constructed on the basis of a series of micro-liquidity measures. To this end, the benchmark specification we employ is:

$$r_{p,d} = \alpha + \beta^{e} \Delta i_{d}^{\ e} + \beta^{u} \Delta i_{d}^{\ u} + e_{d} \tag{5}$$

where $r_{p,d}$ is the return of the liquidity portfolio *p* on the meeting day *d*. Panel A of Table 2 reports the coefficients of model (5) for each liquidity measure considered by pooling information from all ten portfolios. More specifically, these are pooled least squares panel estimates, where the cross sectional units are the ten liquidity-sorted portfolios. The main conclusion from these results is that neither anticipated nor unanticipated interest rate changes affect portfolio returns on MPC meeting days, regardless of the liquidity measure that has been used to sort stocks. Moreover, the explanatory power of these regressions is almost negligible. The only exception is the case where bid-ask spread is considered as a liquidity measure; in this case, the adjusted R^2 is 3%, but the coefficient of the surprise liquidity shock has a puzzling positive sign. In sum, the reported results using the cross-section of liquidity-sorted portfolios for the period June 1999- December 2009 are in sharp contrast to the evidence provided in prior studies (e.g. Bernanke and Kuttner, 2005 for the US and Bredin et al., 2007 for the UK market).

[Table 2 about here]

A casual inspection of the data motivates us to examine whether structural instability lies behind this puzzling finding. In particular, the common perception and finding of previous studies that stock prices rise due to a larger than expected decrease in interest rates was not confirmed during the recent crisis period. As a characteristic example, while the unexpected interest rate decrease, as implied by the futures contract on the 3-month LIBOR, was an astonishing 0.4% on the MPC meeting of 6th November 2008, the FTSE All Share index plummeted by 5.53% on that day.[8] Similarly, the unexpected, relative to market expectations, interest rate decrease of 0.1% on the meeting of 8th October 2008 was associated with a FTSE All Share drop of 4.98%. This puzzling phenomenon has attracted considerable attention in

[8] It is worth noting that the magnitude of this unanticipated decrease is so big because the market was actually expecting an increase in LIBOR on that meeting day. Moreover, the BoE cut its policy rate by a historical record of 1.5%. Hence, it is even more intriguing that the stock market collapsed in the face of the largest unexpected interest rate cut in record.

the financial press; a plausible interpretation is that surprising the market during the crisis by reducing rates more than expected was perceived as a signal for an even bleaker economic outlook by the central bank.[9] Hence, interest rate decreases, instead of boosting stock returns as previously thought, actually signalled worse economic conditions to the investment community and led stock prices to lower levels. On the other hand, rising interest rates could have been regarded as good news, indicating the end of the crisis.[10]

The structural instability argument was formally tested using standard Chow-type tests as well as the Quandt-Andrews unknown breakpoints test (Quandt, 1960, and Andrews, 1993). In particular, the regressions that we estimated using various portfolio returns' time series exhibited a structural break at the beginning of the crisis period, i.e. August- September 2007, symbolically coinciding with the bank run on Northern Rock. Motivated by this evidence and the discussion in Brunnermeier (2009), we introduce a crisis period dummy that spans the period from August 2007 till December 2009.[11] This dummy variable is interacted with the explanatory variables of our benchmark specification in (5), leading to the following model for the MPC meeting day returns of each portfolio:

$$r_{p,d} = \alpha + (\beta^e + \delta_1 DCrisis)\Delta i_d^e + (\beta^u + \delta_2 DCrisis)\Delta i_d^u + e_d \qquad (6)$$

where $DCrisis$ stands for the crisis period dummy variable; it takes the value 1 from August 2007 onwards and 0 otherwise.

Panel B of Table 2 contains the pooled least squares panel estimates of model (6) for each measure considered in this study, utilizing cross-sectional information from all ten portfolios. This simple way of capturing structural instability in the liquidity shocks-portfolio returns relationship leads to a series of highly important findings. Firstly, both expected and unexpected interest rate changes can help explain daily returns in the cross-section of liquidity portfolios on BoE MPC meetings once the effect of the crisis on the relationship is taken into account. The adjusted R^2 of this model can be as high as 11% in case the bid-ask spread is utilized as a measure of micro-liquidity. Secondly, the inverse relationship between unanticipated interest rate shocks and portfolio returns is documented for the period *before* the crisis, confirming the evidence provided by earlier studies and, for the first time in the literature, extending this finding for the case of liquidity-sorted portfolios. This inverse

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[9] Buttonwood also utilizes this line of argumentation in “Another paradox of thrift”, The Economist, 18th September 2010.

[10] See, for example, “Why rising rates is good news”, Financial Times, 14th December 2010.

[11] For robustness, in Section 4 we alternatively characterize a shorter time period as the crisis period.

relationship is true even for anticipated interest rate changes, with the exception of trading volume-sorted portfolios, contradicting the hypothesis that these anticipated changes would have been already incorporated in stock prices and that they should not matter.

Most importantly, we emphatically document that the shocks-liquidity portfolio returns' relationship reverses its sign *during* the crisis period. In particularly, it turns into a positive relationship that is highly significant, statistically as well as economically, for both expected and unexpected changes. In other words, an unexpected (or expected) decrease in the 3-month LIBOR led to a negative portfolio return response *during* the crisis period, while it would have yielded a positive return *before* the crisis. The magnitude of the return responses is also noteworthy; for every measure considered, the positive response to the shock during the crisis was almost twice greater than the negative response (in absolute value) documented before the crisis. In general, the magnitude of the responses estimated by model (6) is much more economically significant than the ones yielded by model (5), which does not consider the crisis effect. This evidence also confirms the conjecture that considering liquidity-sorted portfolio rather than aggregate sectoral indices, could yield more intriguing results regarding the shocks-returns relationship.

The previous set of results was based on pooling information from all ten portfolios we constructed for each micro-liquidity measure. To dissect this evidence, the next step of our analysis is to examine the shocks-returns relationship in the extreme decile portfolios. Table 3 contains the estimated coefficients from model (5) applied to the most liquid and most illiquid portfolio returns, respectively. As it was the case with pooled information, no significant relationship for neither of the two portfolios is reported if one does not take into account the crisis effect. Apart from statistical significance, the point estimates of the coefficients do not lead to any meaningful conclusion either. Interestingly, model (5) has no explanatory power for the returns of the most illiquid portfolio, while this is slightly improved for the most liquid portfolio's returns. These results hold for all six sorting measures considered.

[Table 3 about here]

Motivated by the evidence on the effect of crisis on the shocks-returns relationship in the cross-section of portfolios' returns, we also estimate model (6) for the most liquid and most illiquid portfolio's respectively. Panel A of Table 4 contains the estimates corresponding to each of the micro-liquidity measures we have utilized. The inclusion of the crisis slope dummy variable has a drastic effect on the obtained results. We document that the most liquid portfolio's returns behave dramatically differently from those of the most illiquid portfolio. In particular, model (6) can explain to a large extent the behaviour of the most liquid portfolio's returns on MPC meeting days, while it fails to do so for the most illiquid portfolio's returns. While the adjusted R^2 is negligible for the most illiquid portfolio's returns regardless of the sorting measure considered, it is quite high for the most liquid portfolio's daily returns, reaching the level of 22% for the case of turnover rate.

[Table 4 about here]

Apart from the differential explanatory power that model (6) contains for liquid versus illiquid portfolios' returns, it also highlights the differential response of these returns to macro-liquidity innovations, as these are measured relative to market expectations embedded in the 3-month LIBOR futures contract. In particular, the introduction of the crisis slope dummy variable helps recover again the inverse relationship between interest rate shocks and returns *prior to* the crisis period and emphatically illustrates the reversal of this sign *during* the recent financial crisis; this is true for the most liquid portfolio's returns and it holds for all measures examined. On the other hand, the most illiquid portfolio's returns do not seem to exhibit any kind of relationship to interest rate shocks, neither before nor during the crisis period. This finding is in line with the extensive literature documenting that liquid stocks behave differently from illiquid stocks in terms of premia and risk exposure. It also and illustrates that macro-liquidity shocks is a fundamental factor to which these portfolios are exposed in a differential manner.

A potential source of concern for an event study analysis of portfolio returns is that the estimated coefficients may be distorted by large outliers. It is certain that specific news or other shocks occurring on the specific meeting days that we examine may also cause stock prices to move. To take into account the potential effect of large outliers on the estimated coefficients, we follow Bernanke and Kuttner (2005) and re-estimate model (6) after controlling for large outliers. In particular, instead of crudely excluding observations from our sample, we introduce intercept dummies when the residuals from the no-breaks fitted model take values in excess of 2.6 standard errors (i.e. 1% level of significance).[12]

Panel B of Table 4 contains the estimated coefficients for model (6) after controlling for large outliers. This control considerably increases the explanatory power of the model for

[12] As a further robustness check, we re-estimate model (6) in Section 4 after controlling for other variables, such as exchange rate movements and US stock returns that may exert a systematic effect on these portfolio's returns (see Section 4.2).

both the liquid and the illiquid portfolios. Most importantly, the sign and the statistical significance of the coefficients for the most liquid portfolio's returns remain intact for every measure considered. Though the magnitude of the positive returns' response to shocks during the crisis period is slightly reduced in some cases, the previous conclusions regarding the economic significance and interpretation of this response carry through. On the other hand, almost no response coefficient is statistically significant before or during the crisis for the most illiquid portfolio's returns; the reported higher explanatory power is derived almost exclusively from the intercept dummies introduced to control for large outliers, which have been mainly detected during the crisis period.[13] The main conclusion arising from these results is that the nature of response to interest rate shocks is very different in the cross-section of liquidity-sorted portfolios. In other words, macro-liquidity shocks are transmitted in a differential manner to stocks with different micro-liquidity characteristics. This finding establishes the conjectured link between macro- and micro-liquidity.

To examine further this link, we explicitly test whether this differential response in the cross-section of liquidity-sorted portfolios is statistically significant. Following the preceding analysis we re-estimate models (5) and (6) using as the dependent variable the differential return (spread) between the most liquid and the most illiquid portfolio for each measure we have utilized in this study. Table 5 presents the results corresponding to the case where no dummy variable is utilized. As expected, no response coefficient is found to be statistically significant and only a very small portion of the variation in the returns' spread can be explained by model (5). This finding indicates again that failing to account for the break and sign reversal in the shocks-returns' relationship *during* the crisis period would lead to completely erroneous conclusions regarding its nature.

[Table 5 about here]

Panel A of Table 6 presents the estimated response coefficients for the liquid-illiquid portfolio spread return after accounting for the slope break in the examined relationship (model 6). Panel B contains the corresponding estimates once we control for large outliers in each case. The explanatory power of these regressions is quite high. Though daily returns are quite noisy by nature, these macro-liquidity shocks can explain up to 24% of the most liquid-most illiquid portfolio spread return on MPC meeting days; once we control for large outliers, up to 44% of this variation can be attributed to these shocks. This finding highlights the

[13] The days of the intercept dummies for each case are omitted for ease of illustration but are readily available upon request.

fundamental importance of macro-liquidity, confirming that such shocks are directly transmitted to stock prices via the channels we described in the Introduction.

[Table 6 about here]

The sign and the magnitude of the spread returns' response to these shocks is of great interest too. We document across the various measures we examine that, before the crisis, an inverse relationship between interest rate shocks and the liquid-illiquid spread was holding. With the exception of the bid-ask spread and partly the RtoTR ratio, this inverse relationship is statistically significant. The magnitude of this response is economically significant too. This inverse relationship implies that, *before the crisis period*, an adverse macro-liquidity shock (i.e. increase in interest rates) resulted in liquid stock prices' fall. Along the same lines, a positive shock of macro-liquidity expansion (i.e. decrease in interest rates) was boosting liquid stocks' returns. This finding indicates that macro-liquidity expansion improved further micro-liquidity conditions for liquid stocks and investors were ready to pay higher prices to hold them. A plausible interpretation is that improved micro-liquidity conditions made these liquid stocks even closer substitutes to other highly liquid instruments (e.g. short-term commercial or government paper), and hence the corresponding liquidity premium required by investors was reduced, boosting their prices. On the other hand, the most illiquid stocks' returns were largely unaffected by either expansionary or contractionary macro-liquidity shocks; the investors did not seem to modify the premium they required to hold them. These results remain intact when we take into account the potential effect of large outliers in Panel B of Table 6.

The inverse relationship between the most liquid stocks' returns and macro-liquidity shocks has not just ceased to hold during the crisis period; its sign has been actually reversed. In other words, *during the crisis period*, a decrease in interest rates on BoE MPC meeting days was actually associated with lower returns for the most liquid stocks. The signalling mechanism we mentioned above offers a plausible explanation for this finding. Interest rate cuts during the crisis were regarded to signal worse prospects for the financial system and the macroeconomy, and hence investors fled the stock market, liquidating their positions to hoard cash or cash-like instruments, reduce their risk exposure or meet margin calls. This flight to liquidity or safety (Longstaff, 2004) caused a massive sell off, primarily for the relatively more liquid stocks which were easier to liquidate.[14] During these stressed economic and financial conditions the most liquid stocks ceased to be regarded close substitutes to cash-like instruments, the required premia were increased, and hence their prices were heavily penalized.

On the other hand, the most illiquid stocks were not affected by interest rate shocks during the crisis period, except when the bid-ask and the relative spread are employed for micro-liquidity measurement. An interpretation of this result is that changes in the macro-liquidity conditions did not affect the most illiquid stocks, which were already penalized with a high premium required by investors to hold them. This differential return response between the most liquid and most illiquid stocks is statistically significant at levels lower than 1% across all measures considered. The magnitude of this differential response is overwhelming, underlining the importance of the signalling mechanism of interest rate shocks for the most liquid stocks. As Panel B of Table 6 shows, these results carry through even when we control for large outliers, though the magnitude of the responses' differential is slightly reduced in some of the cases.

To illustrate the reversal of the shocks-returns relationship *during the crisis* for the most liquid portfolio and its differential response relative to the most illiquid via an example, we resort again to the meeting of 6th November 2008 when the unanticipated interest rate decrease took its largest value (0.4%). While this should have normally boosted stock prices, the FTSE All Share index actually fell by 5.53% and the most liquid portfolio exhibited a *negative* return of 10.14% (Turnover rate), 5.94% (Volume), 5.73% (RtoV), 5.69% (Relative spread), 5.55% (Bid-Ask spread), 4.95% (RtoTR). On the other hand, the most illiquid portfolios were not affected to a great extent by this huge shock; for example, the most negative return among the most illiquid portfolios was just 1.65% for the case of relative spread.

4. Robustness checks

4.1. Alternative definition of the crisis period

[14] This conjecture is consistent with the evidence in Nyborg and Ostberg (2010), according to which a tightening in the US interbank funding conditions is associated with an increase in the trading volume of most liquid stocks. Similar is the argument of Skjeltorp and Odegaard (2009), who find that trading activity in the Oslo Stock Exchange increased during the financial crisis only for the most liquid stocks.

The introduction of the slope dummy variable for the recent crisis period in model (6) has played a crucial role for our analysis. As a result, it is legitimate to ask how an alternative definition of the crisis period may affect the reported results. Admittedly, there is no universally accepted date for the end of the crisis. Some analysts even claim that the nature of the crisis is such that it is actually ongoing, being transmitted to different markets such as the sovereign debt market. Nevertheless, a possible candidate for an alternative end-of-crisis date is March 2009, i.e. when the major stock market indices experienced their lowest levels and since then they have rebounded to a great extent.[15] Using this crisis period definition, we re-estimate model (6), but now the slope dummy variable $DCrisis$ takes the value 1 during the period August 2007- March 2009 and 0 otherwise.

Panel A of Table 7 contains the estimated returns' response coefficients for the narrower definition of the crisis period pooling information from all ten liquidity portfolios constructed on the basis of the utilized measures. The panel estimation results are very similar to the ones obtained using the benchmark definition of the crisis period (see Panel B of Table 2). With the exception of trading volume-sorted portfolios, the inverse shocks-returns relationship before the crisis is confirmed. This evidence is highly statistically significant for unanticipated shocks. Most importantly, we confirm the reversal in the sign of this relationship during the crisis period. The economic as well as the statistical significance of the positive response of returns to interest rate shocks remains intact and robust to the narrower definition of the crisis period.

[Table 7 about here]

We further examine in Panel B of Table 7 the robustness of our results from model (6) using the most liquid- most illiquid portfolio return differential as its dependent variable. These should be compared with the results in Panel A of Table 6. Again, our findings are very robust to the alternative characterization of the crisis period. In particular, most liquid portfolios' returns react more negatively than most illiquid portfolios' returns to interest rate shocks *before* and *after* the crisis period. However, *during* the crisis period, most liquid portfolios' returns react far more positively to these shocks relative to the most illiquid portfolios' returns. This finding is highly statistically and economically significant.

4.2. Additional control variables

[15] Arguably, this is an ex post characterization of the end of the crisis, which was not universally accepted at that time. Our sole aim is to examine whether a narrower definition of the crisis period affects our results.

Our analysis has focused on the response of liquidity-sorted daily portfolios' returns to macro-liquidity shocks. Despite the use of an event study methodology, arguably other factors may be driving our results. To take into account potentially omitted variables that may affect UK daily stock returns, we estimate the following augmented regression model:

$$r_{p,d} = \alpha + (\beta^e + \delta_1 DCrisis)\Delta i_d^e + (\beta^u + \delta_2 DCrisis)\Delta i_d^u + \gamma' X_d + e_d \quad (7)$$

where X_d represents the vector of additional explanatory variables. Following Bredin et al. (2007), we consider as additional control variables the daily change in the sterling pound/ US dollar exchange rate, the corresponding change in the sterling pound/ Euro exchange rate as well as the return on the US market as proxied by the S&P 500 index.[16]

Table 8 contains the response coefficients estimated from model (7). Panel A presents the results for the most liquid and most illiquid portfolios' returns, while Panel B shows the corresponding results for the differential returns between these extreme decile portfolios.[17] We are able to confirm the robustness of our previous results, even in the presence of additional explanatory variables. There is a differential response to interest rate shocks between the most liquid and the most illiquid portfolios' returns. This differential response is particularly significant, both statistically and economically, *during* the crisis period. More specifically, most liquid portfolios' returns exhibited a highly positive reaction to macro-liquidity shocks *during* the crisis, while most illiquid portfolios' returns remained largely unaffected.

[Table 8 about here]

4.3. Alternative definition of macro-liquidity shocks

This study has utilized macro-liquidity shocks defined relative to market expectations embedded in the traded futures contract written on the 3-month LIBOR. As mentioned in the Introduction, a series of related studies (see e.g. Nyborg and Ostberg, 2010) have utilized the innovations to the LIBOR-OIS spread as a measure of adverse funding conditions in the interbank market, and hence this spread can be regarded as a proxy of adverse macro-

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[16] Given the time lag between the US and the UK market close, we follow common practice in the literature and use the lagged S&P 500 daily return.

[17] The estimated coefficients for the rest variables are not shown due to space limitations, but they are readily available upon request. We find that for almost all measures, portfolios' returns, both illiquid and liquid, are significantly affected by lagged US stock returns. On the other hand, we find no statistical evidence that the changes in the bilateral exchange rate had an impact on these portfolios' returns.

liquidity conditions. Therefore, in this subsection we seek to examine the response of the micro-liquidity sorted portfolios' return to changes in the LIBOR-OIS spread. For the UK market, we define the equivalent spread as the difference between the 3-month LIBOR (*L*) and the BoE Base rate (*B*). The model we estimate is given by:

$$r_{p,d} = \alpha + \beta \Delta (L - B)_d + e_d \tag{8}$$

where $\Delta(L-B)_d$ stands for the change in the spread on meeting day *d* over the previous trading day *d-1*.

Figure 1 illustrates the values of this spread on the MPC meeting days for the period June 1999- December 2009. An important feature of the LIBOR- Base rate spread is that it becomes very active mainly during the period we have characterized as the financial crisis period. In particular, this spread is almost zero for the most of our sample period and widens considerably only after August 2007. As a result, we do not need to introduce a crisis period slope dummy variable in model (8). This effect is inherently taken into account by the behaviour of the spread. We should stress that an increase in the spread on the MPC meeting day implies an adverse macro-liquidity shock, in the sense that funding conditions for financial intermediaries and market participants deteriorate, either through an increase in the cost of funds or through a reduction in their supply. Following Nyborg and Ostberg (2010), there is no decomposition between anticipated and unanticipated components of this innovation.

[Figure 1 about here]

Table 9 presents the estimated response coefficients from model (8). Panel A contains the results for the most liquid and most illiquid portfolios' returns respectively, while Panel B utilizes the liquid-illiquid decile portfolio differential return as the dependent variable. Overall, the results show a significantly different behaviour between the most liquid and most illiquid portfolios' returns. In particular, we find that the returns of the most liquid portfolios exhibit a negative statistically as well as economically significant response to innovations in the LIBOR- Base rate spread. Moreover, this variable possesses very strong explanatory power with respect to liquid portfolios' returns. The adjusted R^2 of model (8) is as high as 19% when turnover rate is used as a sorting liquidity measure. On the other hand, for most of the measures we considered, the most illiquid portfolios' returns are largely unaffected by innovations in this spread.

[Table 9 about here]

This evidence corroborates our previous finding that the most liquid portfolios' returns are actually the ones that are mostly responsive to macro-liquidity shocks. Results in Panel B confirm that this differential behaviour is highly statistically significant. In line with our benchmark results, the returns of most liquid portfolios are much more heavily penalized, relative to the most illiquid portfolios' returns, due to the adverse shock of an increase in the LIBOR-Base rate spread during the recent crisis period. The interpretation we put forward for this finding and is also supported using this alternative proxy of macro-liquidity shocks is that investors attempted to flee the stock market during this crisis period and mainly liquidated their positions in most liquid stocks, driving down their prices. It is likely that the flight to liquidity from the stock market to the money markets or even just cash holdings did not affect the most illiquid stocks either because these were too costly or difficult to liquidate (consistent with the conjecture of Brunnermeier, 2009, and the evidence provided by Anand, Irvine, Puckett and Venkataraman, 2010) or because they were already incorporating a significant liquidity premium, and hence they were trading at already low prices, rendering them worth withholding.

5. Conclusions

The recent global financial meltdown has brought macro-liquidity to the center stage of analysis for asset prices' fluctuations and the stability of the financial system. This study examines the transmission of shocks affecting the funding liquidity conditions of market participants and financial intermediaries to stock market returns. In particular, we examine the potential link between macro-liquidity shocks and the returns of portfolios sorted on the basis of the shares' micro-liquidity conditions. The focus of our event study analysis is on the shocks extracted relative to market expectations embedded in traded futures contracts on the Bank of England Monetary Policy Committee's meeting days.

There are three important conclusions from our empirical results. First, there has been a structural break in the relationship between macro-liquidity shocks and liquidity-sorted portfolio returns *during* the recent crisis period. Failing to account for this break, one would erroneously conclude that macro-liquidity shocks have no effect on returns. Second, these shocks are transmitted to the cross-section of liquidity-sorted portfolios but in a differential manner between the most liquid and the most illiquid portfolios; the effect is much more statistically and economically significant for the most liquid portfolios. Third, the commonly documented inverse relationship between interest rate surprises and returns *before* the crisis has reversed its sign *during* the crisis. Interest rate cuts *during* the crisis not only failed to boost returns in the short-run, but they actually led liquid stocks to lower prices, because these were perceived by stock market participants as a signal of a worse economic outlook by the Bank of England.

These empirical findings have several important implications for policy makers and market participants. The conventional wisdom that reducing interest rates can boost stock returns in the short-run does not necessarily hold during a severe crisis period. To the contrary, under such conditions, interest rate cuts may actually send the wrong signal to investors who may perceive them as a message that macroeconomic prospects are even worse than previously thought. This signalling effect may actually exacerbate the impact of adverse market conditions, eventually leading investors to flee the stock market, initializing a downward price spiral and posing a serious threat to the stability of the financial system. Moreover, the transmission of these macro-liquidity shocks may affect differentially stocks with different trading conditions. Therefore, dissecting the cross-section of stock returns can prove quite useful for portfolio selection and diversification due to their differential exposure to liquidity risk. This differential risk exposure may lead to differential premia and less correlated price movements. Last but not least, one should not neglect that the response of stock market participants to macro-liquidity shocks, especially during adverse market conditions, is bound to have spillover effects on trading conditions and prices in the money market and the bond market. This issue is left for future research.

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Table 1

Descriptive Statistics and Correlations of Liquidity-sorted Portfolio Returns

Panel A: Descriptive statistics

	Most Liquid Portfolio (P1)					*Most Illiquid Portfolio (P10)*				
Liquidity measure	*Mean*	*Median*	*Max*	*Min*	*St. Dev.*	*Mean*	*Median*	*Max*	*Min*	*St. Dev.*
Bid-Ask spread	-0.11%	-0.00%	4.05%	-6.18%	1.68%	-0.10%	-0.02%	8.36%	-4.72%	1.40%
Relative spread	-0.17%	-0.06%	2.65%	-5.77%	1.26%	-0.08%	0.11%	6.78%	-4.85%	1.27%
Turnover Ratio	-0.34%	-0.25%	6.48%	-10.1%	1.98%	0.03%	0.02%	9.40%	-4.58%	1.26%
Volume	-0.18%	-0.08%	2.75%	-5.94%	1.38%	-0.01%	0.07%	2.96%	-5.54%	0.75%
RtoV Ratio	-0.18%	-0.09%	2.69%	-5.74%	1.28%	0.05%	0.12%	2.83%	-3.43%	0.90%
RtoTR Ratio	-0.23%	-0.11%	3.09%	-5.50%	1.28%	-0.04%	0.03%	5.10%	-3.13%	1.05%

Panel B: Correlation Coefficients

	Most Liquid Portfolios (P1)						*Most Illiquid Portfolios (P10)*					
Liquidity measure	*1*	*2*	*3*	*4*	*5*	*6*	*1*	*2*	*3*	*4*	*5*	*6*
1. Bid-Ask spread	1						1					
2. Relative spread	0.85	1					0.65	1				
3. Turnover Ratio	0.78	0.82	1				0.67	0.65	1			
4. Volume	0.87	0.99	0.85	1			0.35	0.46	0.47	1		
5. RtoV Ratio	0.87	0.99	0.85	0.99	1		0.50	0.54	0.55	0.74	1	
6. RtoTR Ratio	0.79	0.91	0.84	0.92	0.919	1	0.67	0.63	0.79	0.53	0.68	1

Notes: This Table presents descriptive statistics (Panel A) and correlation coefficients (Panel B) of liquidity-sorted portfolios' returns on the Bank of England (BoE) Monetary Policy Committee's (MPC) meeting days. The analysis covers the period June 1999 to December 2009 (128 MPC meeting days). Statistics are reported separately for the portfolio containing the most liquid stocks (P1) and the portfolio containing the most illiquid stocks (P10), constructed on the basis of six measures of microstructure liquidity: Bid-Ask spread, Relative spread, Turnover Ratio, Volume, RtoV Ratio and RtoTR ratio. Analytical definitions for these measures are provided in Section 2.

Table 2

The Response of Liquidity-sorted Portfolios' Returns to Interest Rate Changes (Pooled)

Panel A: Benchmark Specification

Liquidity measure	Δi_t^e *(Expected)*	Δi_t^u *(Unexpected)*	R^2 *adj.*
1. Bid-Ask spread	-1.46	2.26**	0.03
2. Relative spread	-1.10	0.67	0.01
3. Turnover Ratio	-1.38	1.03	0.01
4. Volume	0.24	0.97	0.00
5. RtoV Ratio	0.04	0.90	0.00
6. RtoTR Ratio	-1.57	0.69	0.01

Panel B: The Effect of the Crisis

Liquidity measure	Δi_t^e	*Crisis** Δi_t^e	Δi_t^u	*Crisis** Δi_t^u	R^2 *adj.*
1. Bid-Ask spread	-5.86***	15.35***	-4.53***	20.00***	0.11
2. Relative spread	-3.40***	8.19***	-3.54***	11.97***	0.04
3. Turnover Ratio	-4.34***	10.11***	-3.63***	13.47***	0.05
4. Volume	-1.12	4.72***	-1.24	6.48***	0.02
5. RtoV Ratio	-1.75**	6.27***	-2.08**	8.67***	0.03
6. RtoTR Ratio	-4.90***	11.44***	-4.30***	14.78***	0.05

Notes: This Table presents results from pooled least squares panel regressions of daily returns of liquidity-sorted portfolios (P1 to P10) on the expected and unexpected changes in LIBOR on BoE Monetary Policy Committee's (MPC) meeting days. GLS cross-section weights have been used to account for cross-sectional heteroskedasticity. The analysis is conducted for six liquidity measures and covers the period June 1999 to December 2009 (128 meetings). Panel A reports the estimated coefficients of our benchmark model: $r_{p,d} = \alpha + \beta^e \Delta i_d{}^e + \beta^u \Delta i_d{}^u + e_d$ (5), where $r_{p,d}$ is the return of the liquidity portfolio *p* on the meeting day *d*, $\Delta i_d{}^e$ is the expected change in the interest rate and $\Delta i_d{}^u$ is the unexpected change in the interest rate.Panel B reports the estimated coefficients of a model that introduces a crisis period dummy variable: $r_{p,d} = \alpha + (\beta^e + \delta_1 DCrisis)\Delta i_d^e + (\beta^u + \delta_2 DCrisis)\Delta i_d^u + e_d$ (6), where *DCrisis* is a dummy variable that takes the value of 1 over the period August 2007-December 2009, and 0 otherwise (see Section 2 for details). ***, **, * indicate statistical significance at the 1, 5 and 10% level, respectively.

Table 3
The Response of Most Liquid and Illiquid Portfolios' Returns to Interest Rate Changes

	Most Liquid Portfolio (P1)			*Most Illiquid Portfolio (P10)*		
Liquidity measure	Δi_t^e	Δi_t^u	R^2 *adj.*	Δi_t^e	Δi_t^u	R^2 *adj.*
1. Bid-Ask spread	0.46	2.71	0.00	-4.00	-3.16	0.00
2. Relative spread	-1.55	2.83	0.04	1.87	3.08	0.00
3. Turnover Ratio	3.42	8.43	0.03	0.25	-1.98	0.00
4. Volume	-1.33	3.03	0.03	-1.04	-0.67	0.00
5. RtoV Ratio	-1.34	2.93	0.04	1.56	0.43	0.00
6. RtoTR Ratio	-0.40	2.60	0.01	0.04	-1.33	0.00

Notes: This Table presents results from least squares regressions of daily returns of the most liquid (P1) and most illiquid (P10) portfolios on the expected and unexpected changes in LIBOR on BoE Monetary Policy Committee's (MPC) meeting days. The robust standard errors of Newey and West (1987) have been utilised. The analysis is conducted for six liquidity measures and covers the period June 1999 to December 2009 (128 MPC meetings). We provide the estimated coefficients of our benchmark model: $r_{p,d} = \alpha + \beta^e \Delta i_d^{\ e} + \beta^u \Delta i_d^{\ u} + e_d$ (5), where $r_{p,d}$ is the return of the liquidity portfolio *p* on the meeting day *d*, $\Delta i_d^{\ e}$ is the expected change in the interest rate and $\Delta i_d^{\ u}$ is the unexpected change in the interest. ***, **, * indicate statistical significance at the 1, 5 and 10% level, respectively.

Table 4

The Response of Most Liquid and Illiquid Portfolios' Returns to Interest Rate Changes: The Effect of the Crisis

Panel A: The Effect of the Crisis

	Most Liquid Portfolio (P1)					*Most Illiquid Portfolio (P10)*				
Liquidity measure	Δi_t^e	$Crisis{*}\,\Delta i_t^e$	Δi_t^u	$Crisis{*}\,\Delta i_t^u$	R^2 *adj.*	Δi_t^e	$Crisis{*}\,\Delta i_t^e$	Δi_t^u	$Crisis{*}\,\Delta i_t^u$	R^2 *adj.*
1. Bid-Ask spread	-7.18**	25.55***	-6.63**	28.62***	0.08	-4.68	2.56	-5.10*	5.04	0.00
2. Relative spread	-6.59***	17.39***	-5.35*	23.44***	0.15	4.12	-6.42	1.65	1.06	0.02
3. Turnover Ratio	-8.70**	40.95***	-8.02**	49.07***	0.22	0.81	-1.50	-2.64	0.95	0.00
4. Volume	-6.88***	19.02***	-5.63**	25.02***	0.15	-0.14	-2.87	-0.12	-2.13	0.00
5. RtoV Ratio	-6.62***	18.12***	-5.40*	23.99***	0.15	2.02	-1.50	0.81	-1.31	0.00
6. RtoTR Ratio	-5.39**	16.99***	-4.71	21.42***	0.09	-0.11	0.56	-1.80	1.21	0.00

Panel B: The Effect of the Crisis and Controlling for Large Outliers

	Most Liquid Portfolio (P1)					*Most Illiquid Portfolio (P10)*				
Liquidity measure	Δi_t^e	$Crisis{*}\,\Delta i_t^e$	Δi_t^u	$Crisis{*}\,\Delta i_t^u$	R^2 *adj.*	Δi_t^e	$Crisis{*}\,\Delta i_t^e$	Δi_t^u	$Crisis{*}\,\Delta i_t^u$	R^2 *adj.*
1. Bid-Ask spread	-8.18***	22.36***	-7.95***	27.03***	0.27	-6.40**	4.07	-4.87**	4.63*	0.37
2. Relative spread	-7.20***	12.10***	-6.12**	9.39**	0.44	-1.32	4.01	-0.88	6.51**	0.61
3. Turnover Ratio	-8.75**	25.15***	-8.09**	30.52***	0.43	-0.11	3.15	-0.71	1.08	0.59
4. Volume	-7.52***	14.00***	-6.44**	11.58***	0.41	0.02	2.53	0.14	1.19	0.62
5. RtoV Ratio	-7.26***	13.15***	-6.21**	10.68***	0.42	0.30	3.87	-1.34	3.44	0.50
6. RtoTR Ratio	-6.10***	11.94***	-5.61*	7.78**	0.40	-1.86	2.19	-2.45	1.76	0.23

Notes: This Table presents results from least squares regressions of daily returns of the most liquid (P1) and most illiquid (P10) portfolios on the expected and unexpected changes in LIBOR on BoE Monetary Policy Committee's (MPC) meeting days. The robust standard errors of Newey and West (1987) have been utilised. The analysis is conducted for six liquidity measures and covers the period June 1999 to December 2009 (128 MPC meetings). Panel A reports the estimated coefficients of the model: $r_{p,d} = \alpha + (\beta^e + \delta_1 DCrisis)\Delta i_d^e + (\beta^u + \delta_2 DCrisis)\Delta i_d^u + e_d$ (6), where $r_{p,d}$ is the return of the liquidity portfolio *p* on the meeting day *d*, $\Delta i_d{}^e$ is the expected change in the interest rate, $\Delta i_d{}^u$ is the unexpected change in the interest rate and *DCrisis* is a dummy variable that takes the value of 1 over the period August 2007-December 2009, and 0 otherwise. In Panel B we re-estimate model (6) and report the estimated coefficients after controlling for the impact of large outliers. ***, **, * indicate statistical significance at the 1, 5 and 10% level, respectively.

Table 5

The Response of Portfolio Differential Returns (P1-P10) to Interest Rate Changes

	Most Liquid- Most Illiquid Portfolio Differential (P1-P10)		
Liquidity measure	Δi_t^e	Δi_t^u	R^2 *adj.*
1. Bid-Ask spread	4.46	5.87	0.00
2. Relative spread	-3.42	-0.25	0.02
3. Turnover Ratio	3.17	10.41	0.06
4. Volume	-0.29	3.71	0.03
5. RtoV Ratio	-2.90	2.50	0.07
6. RtoTR Ratio	-0.44	3.93	0.04

Notes: This Table presents results from least squares regressions of differential returns between the most liquid and the most illiquid portfolio (P1-P10) on the expected and unexpected changes in LIBOR on BoE Monetary Policy Committee's (MPC) meeting days. The robust standard errors of Newey and West (1987) have been utilised. The analysis is conducted for six liquidity measures and covers the period June 1999 to December 2009 (128 MPC meetings). We report the estimated coefficients of the model: $r_d = \alpha + \beta^e \Delta i_d{}^e + \beta^u \Delta i_d{}^u + e_d$ (5), where $r_{p,d}$ is the return of the most liquid- most illiquid decile portfolio differential (P1-P10) on the meeting day *d,* $\Delta i_d{}^e$ is the expected change in the interest rate and $\Delta i_d{}^u$ is the unexpected change in the interest rate. ***, **, * indicate statistical significance at the 1, 5 and 10% level, respectively.

Table 6
The Response of Portfolio Differential Returns (P1-P10) to Interest Rate Changes:
The Effect of the Crisis

Panel A: The Effect of the Crisis

Liquidity measure	Δi_t^e	$Crisis * \Delta i_t^e$	Δi_t^u	$Crisis * \Delta i_t^u$	R^2 *adj.*
1. Bid-Ask spread	-2.51	22.99***	-1.54	23.58***	0.06
2. Relative spread	-10.71**	23.80***	-6.99*	22.38***	0.13
3. Turnover Ratio	-9.51***	42.45***	-5.38*	48.13***	0.24
4. Volume	-6.73***	21.89***	-5.51**	27.15***	0.18
5. RtoV Ratio	-8.64***	19.62***	-6.21**	25.31***	0.19
6. RtoTR Ratio	-5.28*	16.43***	-2.91	20.21***	0.11

Panel B: The Effect of the Crisis and Controlling for Large Outliers

Liquidity measure	Δi_t^e	$Crisis * \Delta i_t^e$	Δi_t^u	$Crisis * \Delta i_t^u$	R^2 *adj.*
1. Bid-Ask spread	-1.11	16.64***	-1.26	19.75***	0.44
2. Relative spread	-6.44***	19.59***	-5.74***	21.17***	0.40
3. Turnover Ratio	-8.54***	23.35***	-6.40*	25.77***	0.42
4. Volume	-7.47***	22.85***	-6.49***	28.32***	0.28
5. RtoV Ratio	-9.40***	20.55***	-7.23***	26.15***	0.33
6. RtoTR Ratio	-6.26**	17.47***	-4.22	21.58***	0.31

Notes: This Table presents results from least squares regressions of portfolio differential returns between the most liquid and the most illiquid portfolio (P1-P10) on the expected and unexpected changes in LIBOR on BoE Monetary Policy Committee's (MPC) meeting days. The robust standard errors of Newey and West (1987) have been utilised. The analysis is conducted for six liquidity measures and covers the period June 1999 to December 2009 (128 meetings). Panel A reports the estimated coefficients of following model: $r_{p,d} = \alpha + (\beta^e + \delta_1 DCrisis)\Delta i_d^e + (\beta^u + \delta_2 DCrisis)\Delta i_d^u + e_d$ (6), where $r_{p,d}$ is the return of the most liquid- most illiquid decile portfolio differential (P1-P10) on the meeting day *d*, $\Delta i_d{}^e$ is the expected change in the interest rate, $\Delta i_d{}^u$ is the unexpected change in the interest rate and *DCrisis* is a dummy variable that takes the value of 1 over the period August 2007-December 2009, and 0 otherwise. In Panel B we re-estimate model (6) and report the estimated coefficients after controlling for the impact of large outliers. ***, **, * indicate statistical significance at the 1, 5 and 10% level, respectively.

Table 7
The Response of Portfolio Returns to Interest Rate Changes under a Narrower Crisis Period Definition

Panel A: Pooled estimates based on all ten portfolios (P1 to P10)

Liquidity measure	Δi_t^e	$Crisis * \Delta i_t^e$	Δi_t^u	$Crisis * \Delta i_t^u$	R^2 *adj.*
1. Bid-Ask spread	-4.58***	12.02***	-4.37***	19.23***	0.11
2. Relative spread	-2.33**	5.02***	-3.66***	11.55***	0.06
3. Turnover Ratio	-2.97***	6.05***	-3.54***	12.32***	0.05
4. Volume	-0.33	2.36*	-1.46*	6.39***	0.03
5. RtoV Ratio	-0.92	3.85***	-2.37**	8.79***	0.04
6. RtoTR Ratio	-3.38***	7.04***	-4.27***	13.72***	0.05

Panel B: Most Liquid- Most Illiquid Portfolio Differential (P1-P10)

Liquidity measure	Δi_t^e	$Crisis * \Delta i_t^e$	Δi_t^u	$Crisis * \Delta i_t^u$	R^2 *adj.*
1. Bid-Ask spread	-0.15	16.76***	-0.36	19.80***	0.03
2. Relative spread	-9.14**	20.55***	-6.20*	20.50***	0.10
3. Turnover Ratio	-6.76	36.31***	-4.17	45.26***	0.21
4. Volume	-5.55**	19.35***	-4.87*	25.90***	0.17
5. RtoV Ratio	-7.71***	17.71***	-5.29*	23.57***	0.17
6. RtoTR Ratio	-4.42	14.57***	-2.04	18.43***	0.09

Notes: This Table presents results on the impact of interest rate changes on liquidity-sorted portfolios (Panel A) and Portfolio Differentials (Panel B) after using a narrower definition of the crisis period (August 2007- March 2009). Portfolios are sorted on the basis of the six liquidity measures considered. In particular, Panel A reports pooled least squares panel estimates of the following model: $r_{p,d} = \alpha + (\beta^e + \delta_1 DCrisis)\Delta i_d^e + (\beta^u + \delta_2 DCrisis)\Delta i_d^u + e_d$ (6), where $r_{p,d}$ is the return of the liquidity portfolio *p* on the meeting day *d,* $\Delta i_d{}^e$ is the expected change in the interest rate, $\Delta i_d{}^u$ is the unexpected change in the interest rate and *DCrisis* is a dummy variable that takes the value of 1 over the period August 2007-March 2009, and 0 otherwise. GLS cross-section weights have been used to account for cross-sectional heteroskedasticity. Panel B reports least squares estimation results (with robust standard errors). In Panel B, $r_{p,d}$ is the return of the most liquid- most illiquid decile portfolio differential (P1-P10) on the meeting day *d*. ***, **, * indicate statistical significance at the 1, 5 and 10% level, respectively.

Table 8: The Impact of Interest Rate Changes on Portfolio Returns using other Control Variables

Panel A: Extreme Deciles

	Most Liquid Portfolio (P1)					Most Illiquid Portfolio (P10)				
Liquidity measure	Δi_t^e	$Crisis^* \Delta i_t^e$	Δi_t^u	$Crisis^* \Delta i_t^u$	R^2 adj.	Δi_t^e	$Crisis^* \Delta i_t^e$	Δi_t^u	$Crisis^* \Delta i_t^u$	R^2 adj.
1. Bid-Ask spread	-7.68**	25.41***	-8.52**	27.34***	0.09	-5.28*	3.36	-6.75**	2.45	0.09
2. Relative spread	-7.23***	17.35***	-7.61***	21.52***	0.24	3.49	-6.35	-0.57	-0.80	0.11
3. Turnover Ratio	-9.49***	41.14***	-10.66***	46.37***	0.28	0.16	-1.08	-4.53	-1.78	0.11
4. Volume	-7.51***	18.93***	-7.82***	22.97***	0.23	-0.68	-2.43	-1.81	-4.00*	0.25
5. RtoV Ratio	-7.24***	18.03***	-7.59***	22.02***	0.22	1.48	-0.68	-0.50	-3.95*	0.23
6. RtoTR Ratio	-5.96***	17.52***	-6.50**	19.44***	0.19	-0.60	1.33	-2.64	-2.09	0.13

Panel B: Most Liquid- Most Illiquid Portfolio Differential (P1-P10)

Liquidity measure	Δi_t^e	$Crisis^* \Delta i_t^e$	Δi_t^u	$Crisis^* \Delta i_t^u$	R^2 adj.
1. Bid-Ask spread	-2.40	22.05***	-1.77	24.89***	0.06
2. Relative spread	-10.72**	23.70***	-7.03*	22.32***	0.11
3. Turnover Ratio	-9.65***	42.22***	-6.14*	48.15***	0.22
4. Volume	-6.83***	21.36***	-6.01**	26.97***	0.17
5. RtoV Ratio	-8.72***	18.71***	-7.09**	25.97***	0.19
6. RtoTR Ratio	-5.35*	16.19***	-3.86	21.53***	0.10

Notes: This Table presents least squares results (with robust standard errors) on the impact of interest rate changes on the returns of the most liquid (P1) and most illiquid (P10) portfolios (Panel A) and differential returns between the most liquid and the most illiquid portfolio (P1-P10) (Panel B). The analysis involves daily returns calculated on the BoE Monetary Policy Committee's (MPC) meeting days and covers the period June 1999 to December 2009 (128 MPC meetings). In particular, Panel A reports the estimated coefficients of the model: $r_{p,d} = \alpha + (\beta^e + \delta_1 DCrisis)\Delta i_d^e + (\beta^u + \delta_2 DCrisis)\Delta i_d^u + \gamma' X_d + e_d$ (7), where $r_{p,d}$ is the return of portfolio P1 or portfolio P10 on the meeting day *d*, $\Delta i_d{}^e$ is the expected change in the interest rate, $\Delta i_d{}^u$ is the unexpected change in the interest rate, *DCrisis* is a dummy variable that takes the value of 1 over the period August 2007-December 2009, and 0 otherwise, and X_d represents the vector of additional explanatory variables such as the sterling pound/ US dollar exchange rate, the corresponding change in the sterling pound/ Euro exchange rate as well as the lagged return on the US market, as proxied by the S&P 500 index. In Panel B, $r_{p,d}$ is the return of the most liquid- most illiquid decile portfolio differential (P1-P10) ***, **, * indicate statistical significance at the 1, 5 and 10% level, respectively.

Table 9

The Response of Portfolio Returns to changes in the LIBOR-BoE base rate spread

Panel A: Extreme deciles

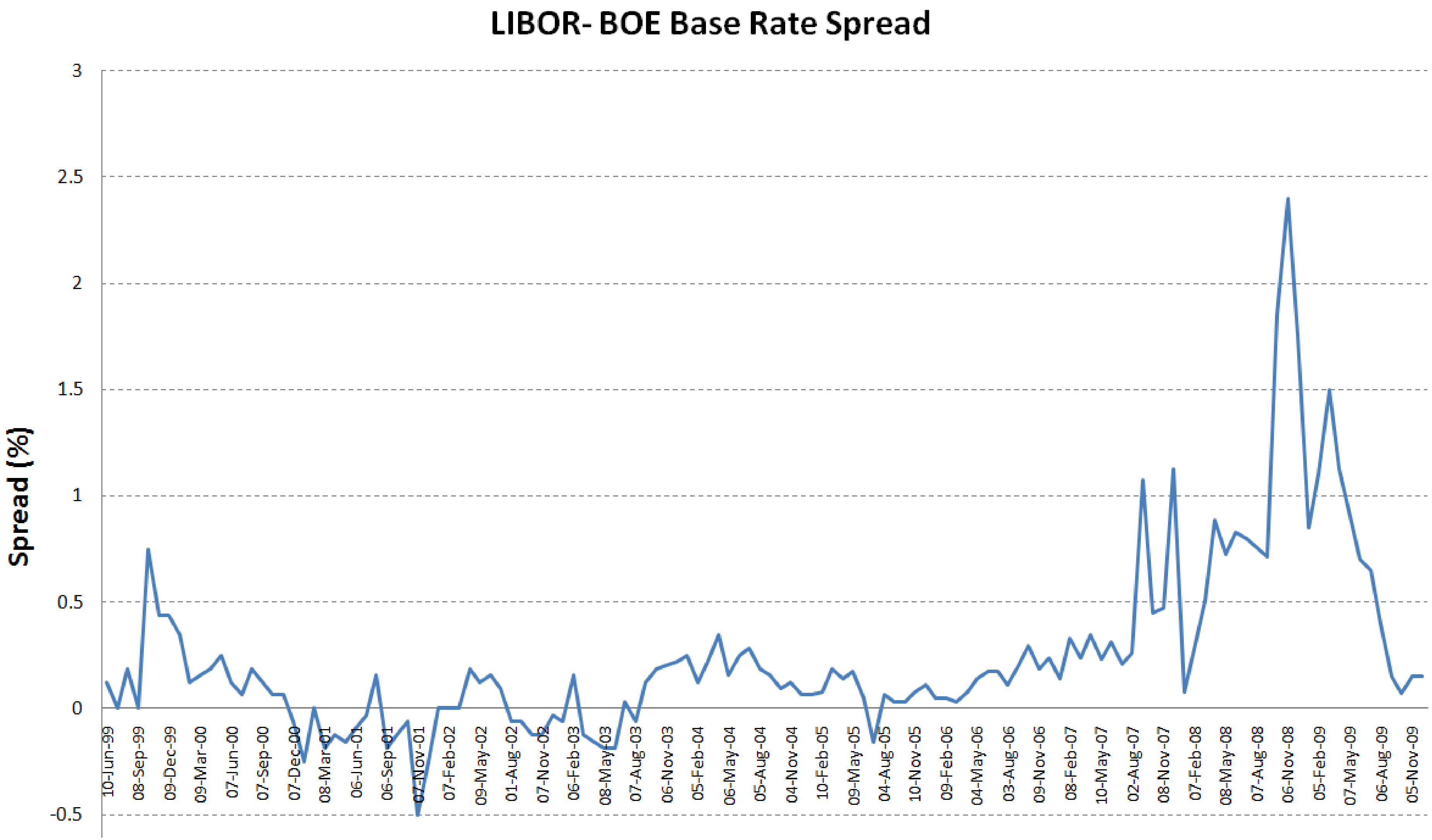
	Most Liquid Portfolio (P1)		*Most Illiquid Portfolio (P10)*	
Liquidity measure	*Δ(L-B)*	R^2 *adj.*	*Δ(L-B)*	R^2 *adj.*
Bid-Ask spread	-2.79***	0.10	-0.25	0.00
Relative spread	-2.47***	0.14	-0.53	0.00
Turnover Ratio	-4.42***	0.19	0.04	0.00
Volume	-2.55***	0.14	-0.82**	0.04
RtoV Ratio	-2.48***	0.14	-0.66***	0.01
RtoTR Ratio	-2.56***	0.15	-0.45	0.00

Panel B: Most Liquid- Most Illiquid Portfolio Differential (P1-P10)

Liquidity measure	*Δ(L-B)*	R^2 *adj.*
Bid-Ask spread	-2.54***	0.08
Relative spread	-1.94***	0.08
Turnover Ratio	-4.46***	0.18
Volume	-1.74***	0.07
RtoV Ratio	-1.82**	0.07
RtoTR Ratio	-2.11***	0.10

Notes: This table reports the least squares results (with robust standard errors) of the impact of changes in the LIBOR-BoE base rate spread (two week repo rate) on the daily returns of the most liquid (P1) and most illiquid (P10) portfolios (Panel A) and differential returns between the most liquid and the most illiquid portfolio (P1-P10) (Panel B). The analysis involves daily returns calculated on the BoE Monetary Policy Committee's (MPC) meeting days and covers the period June 1999 to December 2009 (128 MPC meetings). The LIBOR-BoE base rate spread is defined for the UK market as the difference between the 3-month LIBOR (*L*) and the BoE Base rate (*B*). We report the estimated coefficients of the model: $r_{p,d} = \alpha + \beta\Delta(L-B)_d + e_d$, (8) where $\Delta(L-B)_d$ stands for the change in the spread on meeting day *d* over the previous trading day *d-1*. ***, **, * indicate statistical significance at the 1, 5 and 10% level, respectively.

Figure 1



Notes: This Figure shows the spread between the 3-month LIBOR and the Base rate (two week repo rate) of the Bank of England (BoE) on BoE's Monetary Policy Committee meetings days. These meetings days cover the period from June 1999 to December 2009, yielding a total of 128 observations.