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market during the 2007-08 financial crisis*

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Abstract

This paper provides a detailed analysis of the functioning of the overnight (O/N) unsecured euro money market during the 2007-2008 financial crisis by looking at the time patterns of interest rates, market turnover and banks' borrowing costs. The aim is to disentangle the impact of market events – since the outbreak of tensions in the summer of 2007 until the end of November 2008 – from seasonal patterns of market activity, movements determined by the Eurosystem's operational framework, the impact of the ECB's exceptional crisis-related interventions. The results show the important role, alongside market events, of the additional refinancing provided by the ECB and of credit institutions' increased tendency to hoard surplus reserves rather than trading them in the secondary market. Higher counterparty credit risk and seasonal factors are important determinants of O/N rates and volumes; the exceptional provision of liquidity by the Eurosystem and the relevant changes to the operational framework have influenced banks' incentives to trade liquidity in the market. The analysis of banks' costs for uncollateralised loans provides evidence of the major role of bank reputation and, during the crisis, of a too-big-to-fail guarantee implicitly granted by the market to the banks with the highest volumes of business and of a retrenchment towards national trading counterparties.

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1. Introduction

The events that plagued financial markets during 2007-2008 offer the most recent opportunity to test the functioning of the euro money market during a financial crisis. In a period when banks are possibly exposed to large losses and to a massive confidence crisis they might be expected to refrain from the potentially risky investment of lending, especially if unsecured, to another institution that in turn might have been affected by the ongoing crisis. When this actually occurs, the smooth flowing of liquidity among banks might be impaired and the interbank market may suddenly switch from a locus where banks co-insure against liquidity shocks (as in the seminal paper by Allen and Gale, 2000) to a locus where shocks are possibly amplified and banks are inopportunately cut off from financing.

The plan of this paper is to go through what happened in the euro money market in 2007-2008 by answering three questions:

1. Did the crisis hamper the operational efficiency – as defined in the European Central Bank's (ECB) guidelines – of monetary policy implementation?
2. Did the market continue to effectively channel overnight (O/N) funds during the crisis?
3. How did bank size, reputation, nationality and pre-crisis riskiness affect the cost of O/N funding after the outbreak of the crisis?

Using data on O/N unsecured loans from the e-MID, an Italian electronic trading platform, this paper provides a detailed analysis of the time patterns of interest rates and traded volumes, as well as of individual banks' borrowing costs during the crisis. The aim is to disentangle the impact of market events – since the outbreak of tensions in the summer of 2007 until the end of November 2008 – from seasonal patterns of market activity, regular movements determined by the Eurosystem's operational framework, the impact of the ECB's exceptional interventions during the crisis. In particular, the functioning of the O/N money market is looked at in terms of (i) the operational efficiency of monetary policy implementation, i.e. how precisely and quickly the policy rate decision fed through to O/N rates; (ii) the total gross and net market turnover; (iii) the pricing of individual bank loans.

Overall, the analysis documents that the O/N segment was not immune to the dislocations that affected the term segments of the market since August 2007. As regards the operational efficiency of monetary implementation, the results show that until 29 September 2008 the market events chosen as crisis breakpoints had only a minor impact on the precision with which the policy rate decision fed through to the O/N rate (measured by the spread between the daily average O/N rate in e-MID and the ECB's policy rate). Besides market events, the documented downward pressure on the average market rate (and hence on the spread) during the crisis is explained by the additional refinancing provided by the ECB (and by the larger amounts absorbed at Fine Tuning Operations, FTOs), and by credit institutions' higher tendency to hoard excess reserves, documented by the increasing amount of

reserves deposited at central banks (CBs) and the higher recourse to the deposit facility. A related concurrent factor might have been a lower demand for O/N liquidity in the secondary market, since the abundant surplus of funds offered by the Eurosystem made it less necessary than before for many banks to rely on the interbank market to borrow cash. A downward shift in demand was partly driven also by the increased attractiveness of the ECB's tender operations due to its collateral framework. In fact, the relevant changes to the Eurosystem's operational framework, especially after 9 October 2008, have influenced banks' bidding behaviour in the primary market (see Eisenschmidt, Hirsch and Linzert, 2009) and, thereafter, banks' incentives to trade in the secondary market. On the other hand, increased counterparty credit risk and seasonal factors can capture an increase in the spread, similarly to what typically occurs in normal times.

Market events had a significant impact on the rapidity of the transmission of the policy stance to interbank rates (measured by their intraday variability) both immediately after the start of the turmoil and after the end of September 2008. The notable increase in the cross-section dispersion of O/N rates in the days of allotment of supplementary FTOs since 9 August 2007 could reflect different degrees of liquidity imbalance of e-MID borrowers and/or the exploitation of some market power by banks that managed to borrow at those supplementary operations. However, like in normal times, also during the crisis the strongest *ceteris paribus* increase of intraday volatility occurred at the end of reserve maintenance periods.

The analysis of the e-MID turnover documents that the market events chosen as crisis breakpoints did have a strong negative impact on traded volumes, far bigger than the decrease that can be attributed to banks hoarding surplus reserves. The almost perfect correlation throughout the sample period between the amount of reserves that banks deposited at CBs and the total refinancing provided by the Eurosystem suggests that the lower turnover in the secondary market can partly be attributed to a crowding out of private trading activity by the ECB. Interestingly, the economic size of the combined effect of a looser liquidity provision by the ECB and a higher hoarding of reserves by banks is not very large compared to market events as long as we consider only the allotment of Main Refinancing Operations (MROs) and FTOs. However, if we take into account also the supplementary provision of long-term funds by the ECB, then market events can capture the decline in turnover only at the very start of the crisis, while the allotment of supplementary Long Term Refinancing Operations (LTROs) captures a sizable 7% decrease in traded volumes. In addition, it is worth to emphasize that the transparency of the e-MID electronic trading mode might have had an amplifying role by inducing banks to search for alternative (less transparent) sources of funding.

Finally, as regards the analysis of individual banks' borrowing costs, the analysis confirms the guess that in normal times banks with a stronger reputation enjoy on average better funding conditions in the e-MID market. At the same time, being bigger or Italian does not reduce significantly the price of an O/N loan. However, things changed after the start of the crisis, and most notably after the bailout

of large European banks following 29 September 2008: being bigger resulted in a significant decrease of the price paid for O/N loans; being foreign implied paying more than Italian banks. The effect of bank reputation became remarkably stronger. This evidence is consistent with a retrenchment towards national counterparties in a market previously perceived as extremely well integrated, and with the presence of a remarkable “too-big-to-fail” effect in times of increased liquidity and credit uncertainty.

The rest of the paper is structured as follows. A short paragraph introduces the European interbank market and some relevant developments during 2007-2008. Section 2 reviews some related literature. Section 3 presents the main data source and the methodology used for the empirical analysis, and introduces the Eurosystem’s operational framework. Section 4, 5 and 6 present the empirical findings. Section 7 concludes.

1.1 The euro interbank market before and after 9 August 2007

Money markets are of great importance to modern financial systems. First, in these markets CBs intervene to implement their monetary policy stance. Second, well functioning money markets effectively channel liquidity from institutions with a surplus of funds to those in need. Under normal market conditions interbank rates are determined almost on a one-to-one basis by changes in the main policy rate. This explains why CBs and policymakers have an interest in having money markets where institutions efficiently trade liquidity, delivering the desired allocation of reserves within the banking system at the rate decided upon by the central bank. A market freeze of the type observed during the financial crisis may impair the transmission mechanism of monetary policy, forcing CBs to active interventions and possible undertaking of credit risk. More importantly, by damaging financial intermediation, a freeze might impair lending to the real economy. In normal times unsecured interbank markets are highly competitive and among the most efficient and well-integrated, as informational asymmetries and counterparty credit risk tend to be rather limited.² For the O/N maturity – the most relevant of the unsecured segment – adverse selection and moral hazard do not seem to play a key role, if any, as concerns about creditworthiness at such a short maturity are less relevant. Moreover, overnight interbank trading is strongly influenced by the Eurosystem’s operational framework – i.e. refinancing with the ECB and reserve requirements – which makes its functioning relatively more mechanical and less driven by market participants’ speculative behaviour.

However, the financial turmoil that started in the summer of 2007 in the wake of the US sub-prime mortgage crisis has disrupted “normal” market conditions. Since the outbreak of tensions CBs worldwide have been under pressure to tackle a rise in borrowing costs between banks and an almost

² “The unsecured market is the least concentrated money market segment. According to qualitative answers provided by counterparties, this segment is perceived as being very efficient (...) On the basis of the price-based indicators, the unsecured market became highly integrated almost immediately after the introduction of the euro.” (ECB, 2007).

complete drying up of liquidity in the money markets beyond the shortest maturities.³ A grim problem faced by CBs was the difficulty in getting open market operations, discount windows or lending facilities to channel liquidity to the parts of the system where it was needed most. This is why they decided to adjust their operations to retain control over the relevant short-term rates and to promote orderly market conditions.⁴ When financial tensions hit the euro money market, on 9 August 2007, the ECB responded by providing supplementary liquidity. The Euro Overnight Index Average (EONIA) fell in response to the ECB's liquidity injection but 1 and 3 months Euribor rates surged, thus marking the start of a highly unusual period in the money markets, whose cause maybe qualifies as one of Taleb's "black swan" events (see Taylor and Williams, 2009).

Figure 1(left side) plots the reaction of the money market to the black swan. We see the incremental surge in the 3 months Euribor fixing since the start of 2007 and the sudden jump in the OIS spread and the iTraxx Europe Senior Financials Index since August 2007.⁵ Both variables are used as measures of counterparty credit risk in the euro area. Therefore, the figure reveals that one trigger behind the increase of unsecured interbank rates was a higher perception of the risk of default of counterparties, with the consequent generalized upward correction in the pricing of such a risk. In addition, Figure 1(right side) shows the reaction of the Eurosystem to the black swan. Since August 2007 the ECB increased the size and frequency of FTOs; moreover, it changed the composition of its liquidity operations in favour of LTROs (and reducing the amounts allotted at weekly MROs). Starting from 29 September 2008 the Eurosystem increased the amounts of liquidity outstanding and announced relevant changes to its operational framework, e.g. the narrowing of the interest rates' corridor, the switch to fixed rate–full allotment tenders in MROs and LTROs, the broadening of eligible collateral. Correspondingly, in Figure 2 (left side) we can identify three qualitatively different phases of market functioning.⁶ The first, prevailing until 9 August 2007, could be defined as normal functioning, characterized by a low and stable OIS spread and an almost nil recourse to the Eurosystem's standing facilities. The second phase is the one depicting the reaction to the black swan: spreads and indicators of counterparty credit risk witnessed record highs. Although under strains, the interbank market continued to function also thanks to the exceptional support of the ECB. A third phase seems to have started after 25-29 September 2008, i.e. after the spread out of the crisis to large European commercial banks: the market witnessed an additional strong rise in the spread, an increase

³ For comprehensive descriptions of the crisis see, among others, BIS (2008), Borio (2008), Brunnermeier (2009), Greenlaw et al (2008), Taylor and Williams (2009).

⁴ To a degree that depended on the extent and nature of the dislocations and on the features of the operational frameworks, measures included: increasing size and frequency of operations; adjusting terms on standing facilities, discretionary operations and arrangements influencing banks' demand for reserve balances; broadening the range of counterparties and eligible collateral; lengthening the maturity of liquidity injections.

⁵ The OIS spread is the difference between 3m Euribor and 3m Overnight Indexed Swap (OIS) rate. OIS and Eurepo rates are the commonly used baseline against which unsecured money market rates (e.g. Euribor) are assessed. The iTraxx Europe Senior Financials index is based on a basket of Credit Default Swaps (CDS) of 25 members headquartered in the euro area.

⁶ See Heider, Hoerova and Holthausen (2009).

in the amounts of reserves deposited with central banks, and a far higher recourse to the ECB's standing facilities (Figure 2, right side).

Figure 1: The reaction of the euro money market and, consequently, of the Eurosystem to the black swan

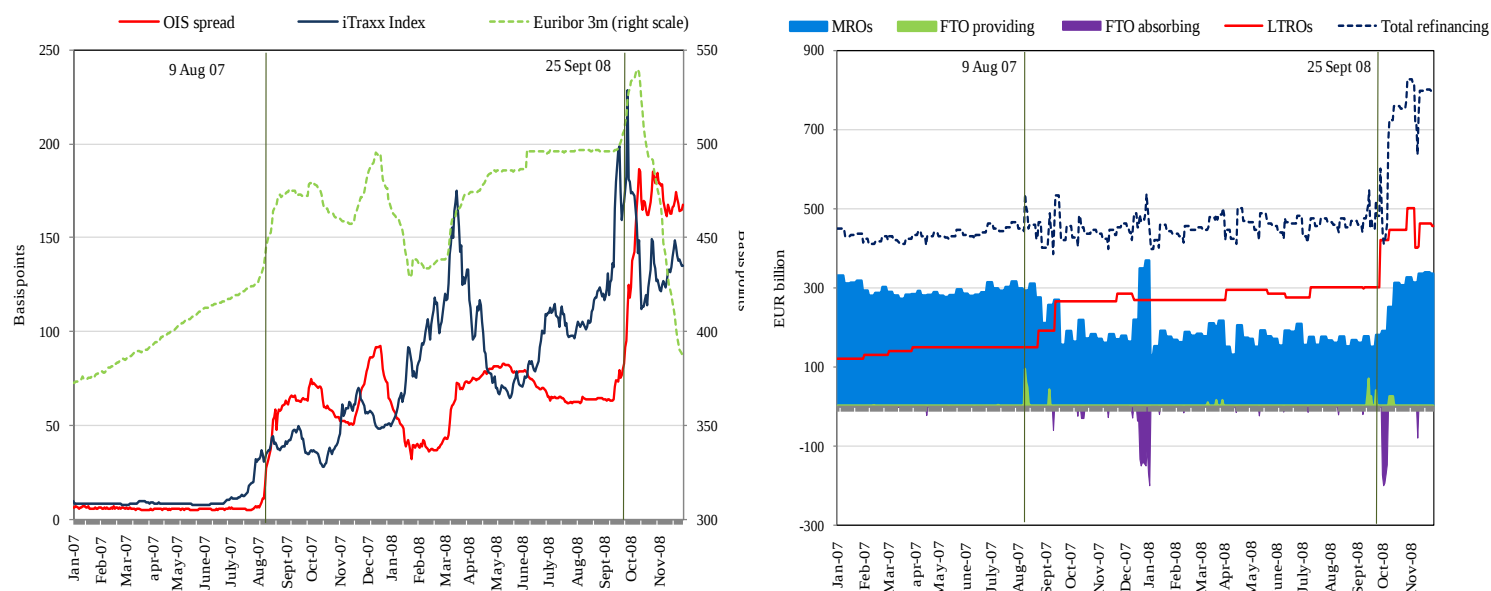
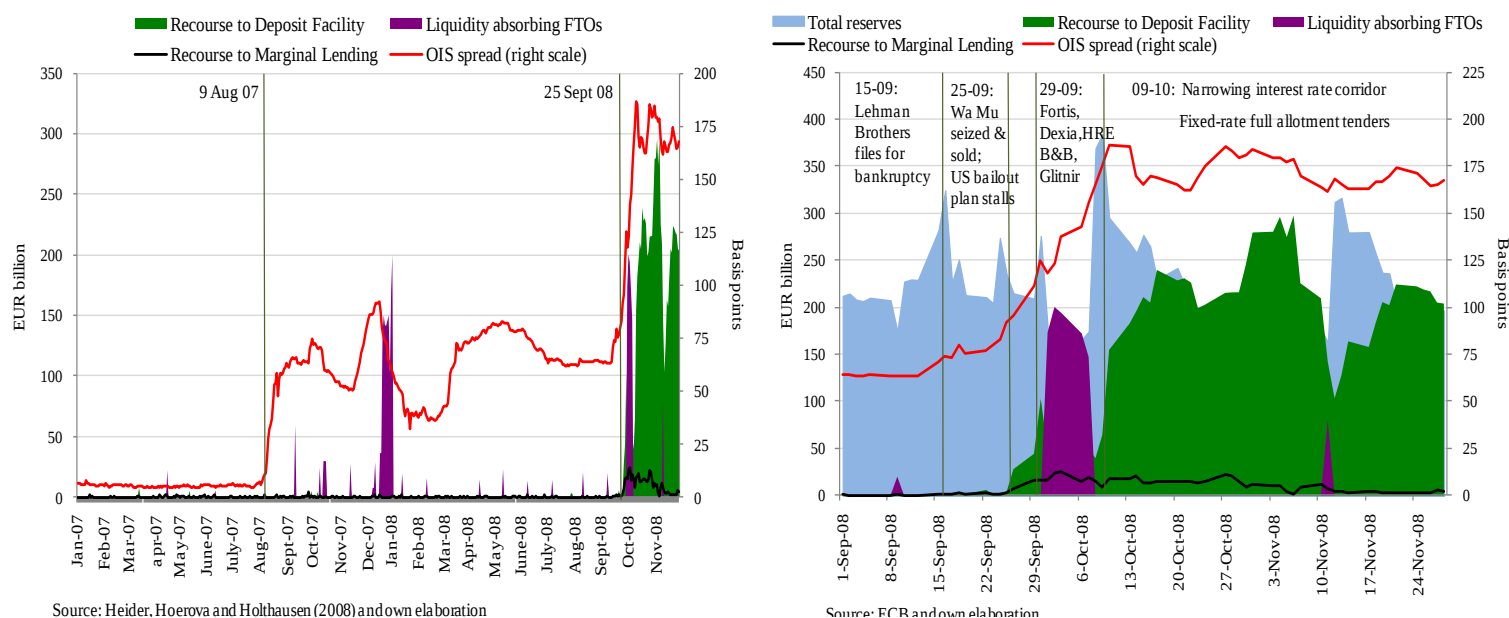


Figure 2: The euro money market after 9 August 2007



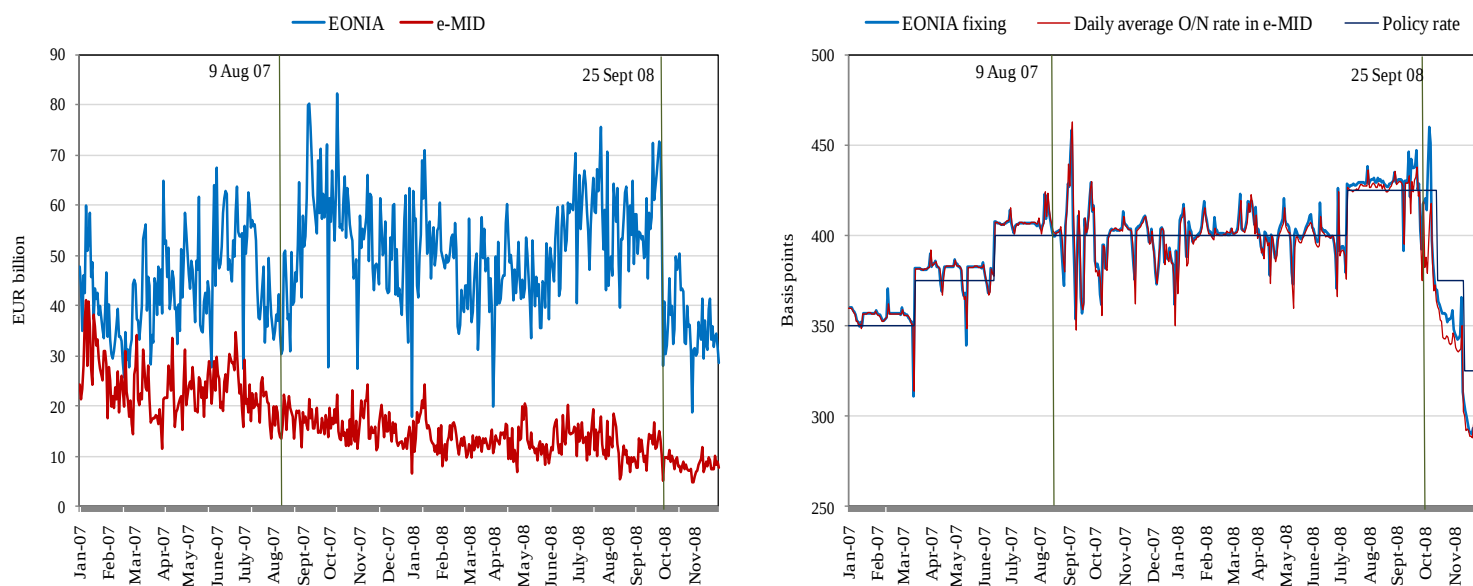
Source: Heider, Hoerova and Holthausen (2008) and own elaboration

Source: ECB and own elaboration

Finally, Figure 3 plots developments over time of daily turnover (left side) and average daily interest rate (right side) of the O/N euro money market as revealed by the two main sources of information

about this market, the EONIA and the e-MID.⁷ The time series show that O/N volumes have decreased steadily in e-MID since July 2007 (and even earlier), while EONIA volumes have actually increased after the start of the turmoil and witnessed a decline only after 29 September 2008. While e-MID volumes do not offer a trustworthy picture of the market after the start of the crisis, O/N weighted average rates are extremely close to the EONIA fixings both before and throughout the crisis (with the only exception of the 10 days elapsing from 26 September until 8 October 2008).

Figure 3: Daily turnover and average daily O/N rate of EONIA and of e-MID banks



2. Related literature

Before 2007-08 the seminal papers on money markets were mostly theoretical. Some models focused on the rationale behind the existence of a wholesale market for liquidity in which banks co-insure against liquidity shocks (e.g. Bhattacharya and Gale, 1987, Rochet and Tirole, 1996 and Allen and Gale, 2000). A more notable strand of the literature discussed instead the potential for interbank market failures. Focusing on how the market operates, this literature has identified several tensions able to disrupt its functioning in times of crisis. Beside banks' free-riding on each other's liquidity (as in Bhattacharya and Gale) these are: asymmetric information about the quality of banks' assets (Flannery, 1996 and Freixas and Jorge, 2007), banks' free-riding on the central bank's liquidity (Repullo, 2005), or contagion through the interbank market (Allen and Gale, 2000). Some seminal models are actually able to capture aspects of the recent market dislocations, hence are more directly relevant for this work. For instance, in Flannery's (1996) model higher uncertainty about the

⁷ The 44 banks with the highest volumes of business in the euro zone money markets form the EONIA (and Euribor) panel. They report daily to the ECB the weighted average rate and the total volume of their O/N unsecured lending transactions, used to compute the EONIA fixings (rate and volumes, respectively). The e-MID platform has almost 200 participants. Credit institutions willing to participate in e-MID are required to have total net assets of at least USD 10 million; the requirement increases to at least EUR 300 million for investment companies.

creditworthiness of counterparties induces banks to abstain from interbank lending, while in Freixas, Parigi and Rochet (2000) a bank chooses not to lend in the market because it doubts its own ability to borrow in the future (and thus it hoards “precautionary” liquidity). The testable outcome of these frictions is a decrease in market turnover coupled with a significantly higher amount of reserves deposited with the central bank and a higher recourse to its deposit facility – something I find evidence of in my analysis.

In the wake of the financial turmoil, a renewed interest on inefficiencies in the interbank market has emerged. Acharya, Gromb and Yorulmazer (2008) make the hypothesis that the failure of this market during a crisis stems from the strategic behaviour of surplus banks, as they will have an incentive to acquire additional liquidity in open market operations and hoard it to inefficient levels or ration needy banks. Heider, Hoerova and Holthausen (2008) model the unsecured interbank market introducing asymmetric information about counterparty risk. They show that if counterparty risk increases sufficiently the market can switch to a regime in which lenders inefficiently hoard liquidity. In Allen, Carletti and Gale (2009) banks can stop trading, hence “freezing” the market, due to aggregate liquidity risk, i.e. when banks hold similar rather than offsetting positions.

The empirical literature on the functioning of interbank markets in times of financial distress has suffered from the limited transparency of these markets, where trading occurs mostly over-the-counter (OTC). An important exception is Furfine (2002) who studied the functioning of the US federal funds market during the 1998 crisis by developing a methodology to recover O/N loans from payment data. Afonso, Kovner and Schoar (2010) use this methodology to study the impact of the bankruptcy of Lehman Brothers on the Federal Funds market. Concerning the euro money market, a comprehensive analytical study is published by the ECB every two years based on survey data collected on an annual basis by experts from the European System of Central Banks.⁸ Furthermore, the crisis has spurred a fast growing empirical literature on the impact of the crisis on money markets thanks to the availability of a unique source of information on interbank trading such as the e-MID platform. For instance, Cassola, Holthausen and Lo Duca (2008) analyse changes in intraday trading and cross-country lending patterns in the O/N money market, providing evidence of stronger asymmetric information and of a move against market integration. Angelini, Nobili and Picillo (2009) analyse the determinants of the sharp increase in interbank spreads at term maturities since the summer of 2007. Brunetti, di Filippo and Harris (2009) test whether ECB’s interventions improved liquidity in the market. Schwartz (2009) disentangles credit and liquidity risk in interest rate spreads.

⁸ Hartmann, Manna and Manzanares (2001) were the first to use a small survey conducted among money market dealers to analyze the euro interbank market microstructure. Since 1999 the ESCB regularly collects survey data for the second quarter of each year from money market participants. Based on these data, every second year the ECB publishes the *Euro Money Market Study* (the last available study has been published in December 2010 on survey data for the second quarters of 2009 and 2010). For a recent survey on euro zone money markets – their scope and economic functions, stylized facts and policy issues – see Hartmann and Valla (2007).

The following studies on the microstructure of the euro money market are of the utmost importance for my empirical analysis: Beaupain and Durré (2008), who provide a comprehensive analysis of market interday and intraday dynamics until April 2007; Iori et al. (2008) who study the network topology of e-MID by applying methods of statistical mechanics; Baglioni and Monticini (2008) who measure an intraday term structure of interest rates in e-MID, i.e. the presence of a clear downward pattern of the O/N rate throughout the trading session, with banks borrowing at a premium early in the morning and at a discount at the end of the day.

3. Data set, empirical methodology and operational framework

3.1 Data set

The empirical analysis of this paper is based on data on unsecured euro-denominated loans traded on the e-MID. e-MID SIM S.p.A. is a screen-based electronic market where a set of almost 200 banks operating in the euro area exchange interbank deposits. From the end of 2006 until mid-2008 the share of transactions executed via e-MID in the unsecured euro money market has remained roughly unchanged at 17%, while OTC transactions accounted for the remaining part.⁹ The data set consists of tick data on interbank loans from 2 January 2007 until 28 November 2008. Out of 197,163 trades 176,040 (i.e. 89.3%) are overnight (O/N); they account for about 91% of the total turnover of e-MID. Each transaction records time, price, size, “proposing” and “ordering” institution of the loan, and can be either a *buy* or a *sell*. A buy is an interbank loan proposed (quantity and interest rate) by the borrowing bank, i.e. by an institution submitting a bid quote on the screen, hence revealing itself as liquidity-short to the market; a sell is an interbank loan initiated by the lender, i.e. by an institution submitting an ask quote on the screen, hence revealing itself as liquidity-long.¹⁰

There are two main reasons why I decided to focus on the shortest maturity of the unsecured segment. First, a persistent feature of the unsecured market is that most of its turnover, as regards both lending and borrowing, concentrates in the O/N bucket. Given that default risk at this maturity is the lowest of any unsecured transaction and that unsecured trades are relatively simple to settle (e.g. compared with repo transactions), O/N unsecured loans have traditionally been preferred by bank treasury departments for the management of day-to-day flows. Second, while perceived as very efficient by most of the credit institutions that took part in the last euro money market survey before the crisis, the O/N segment was not immune to the dislocations that affected the term segments since August 2007.

The transparency of e-MID has been one of the main assets of the platform since its launch in 1990 and then since its redenomination in Euro in 1999. The money market survey of 2006 pointed out

⁹ See *Euro money market study 2008* (ECB, February 2009).

¹⁰ Identities of borrowing/lending banks are unknown, but their nationality is known.

how, during the first ten months of that year, the trend observed in the contributions of foreign counterparties and large deals (defined as trades above EUR 100 million) to daily volumes of O/N contracts in e-MID could signal a shift of large deals from countries with voice brokers to the platform. However, developments in the turnover of e-MID since the summer of 2007 seem to suggest that the transparency of the platform turned out to be a disadvantage for its functioning.

Before entering the analysis in detail it is worth emphasizing that, notwithstanding the high market share of e-MID in the period under analysis, any generalisation of the results to the overall population of European banks, especially after the end of September 2008, would need careful consideration.¹¹

3.2 Empirical methodology

I estimate a set of regressions where I use a vector of crisis-dummies (defined based on 5 crisis sub-periods from 31 July 2007 until end-November 2008) to shed light on the impact of the market events chosen as breakpoints – relative to normal times – on the following endogenous variables:

- Average daily spread between the O/N interbank rate and the ECB's policy rate;
- Intraday variability of interbank rates;
- Gross and net daily market turnover;
- Average interest rate spread paid for O/N funds by individual banks.

Controlling for the ECBs' exceptional interventions during the crisis, for time varying variables that affect the interbank market in general and its O/N segment in particular, and for seasonal and calendar-related movements that regularly influence the market, the coefficients on the crisis dummies are meant to capture the impact of the market events that took place in each sub-period on the variables of interest. Appendix A reports summary statistics of the dependent variables and of the regressors; Table 4 describes in detail the variables used on the right-hand side of estimated equations.

The five crisis sub-periods are defined using the following events as breakpoints: (1) the filing for bankruptcy on 31 July 2007 of two Bear Stearns' hedge funds; (2) the announcement on 9 August 2007 by BNP Paribas that it would suspend redemptions from three money market funds; (3) the USD 5.3 billion Government injection of funds into UBS on 2 October 2007; (4) the brokered rescue of Bear Stearns by JP Morgan Chase on 14 March 2008; (5) the bailout of Fortis (followed by Hypo Real Estate, Bradford & Bingley, Glitnir, Dexia) on 29 September 2008 (a detailed timeline of

¹¹ As shown in Figure 3, e-MID weighted average rates are extremely close to EONIA fixings; thus they offer a trustworthy picture of the market. In fact, before accepting any proposal and executing a trade, e-MID participants can arbitrage between the e-MID and the OTC market. While they cannot access best quotes from an aggregate order book, they do access on their screens real time information concerning all trades executed during the day up to the latest and get an indication of prevailing OTC market conditions looking at quotes on Reuters (see http://www.e-mid.it/images/stories/file/e-MID_Regulations.pdf). While this holds true also after September 2008, the number of banks that continued to use the platform regularly reduced remarkably, which resulted in the increasing divergence between EONIA and e-MID turnover.

relevant market events is reported in Appendix B).¹² While tensions related to the US sub-prime crisis, both in terms of deviations of O/N rates from the policy rate and of their intraday variability, became most visible in the money market starting from 9 August 2007, I use as breakpoint for the first crisis sub-period the default of two Bear Stearns' hedge funds that had been struggling for their exposure to so called CDOs of ABS (highly rated derivatives based on subprime mortgages) since mid-July 2007. I deem this event especially important in the unfolding of the crisis (i) because of the large amounts of money these funds had lost incredibly quickly, (ii) because losses were disseminated globally (iii) and, even more importantly, because of Bear Stearns' admission that it "could not figure out exactly how much money it had lost through its exposure to the funds". Since then, the unsatisfying answers to the question of where else were similar problems buried, and of how much exposure an institution really had to the subprime through the variety of versions of CDOs that had been available to investors worldwide, suddenly made markets highly volatile.¹³

Crisis sub-periods:	
(1) 31 July 2007 – 08 Aug 2007	Two Bear Stearns' hedge funds file for bankruptcy on 31 July 2007
(2) 09 Aug 2007 – 01 Oct 2007	BNP Paribas suspends redemptions from three money market funds
(3) 02 Oct 2007 – 13 Mar 2008	UBS receives Government support
(4) 14 Mar 2008 – 26 Sept 2008	Fed-brokered rescue of Bear Stearns by JP Morgan Chase
(5) 29 Sept 2008 – 28 Nov 2008	Bailout of large EU commercial banks (Fortis, HRE, B&B, Dexia,..)

In Sections 4 and 5 I run OLS regressions using daily data from January 2007 until November 2008. Standard errors are estimated using Newey-West heteroskedasticity and autocorrelation consistent estimators. The Newey-West procedure (Newey and West, 1987) allows to address the correlation of unknown form in the residuals of a time series; it assumes that such serial correlation approaches zero as the distance between observations goes to infinity.¹⁴ In Section 6 I run pooled OLS as well as fixed effects regressions clustering standard errors at borrower level. Peterson (2009) shows the very good properties of this procedure in finance panel data sets. In the specific case at hand, clustering allows to control for time-varying bank heterogeneity (e.g. due to daily refinancing needs of the bank, or to its risk aversion) that likely affects the price paid for interbank loans, hence implying a (downward) bias of OLS White standard errors. Preliminary analysis of the structure of the data and, therefore, of the serial correlation of estimated standard errors confirms the intuition of a significant (non fixed) bank

¹² Alternative market events have been tested as breakpoints. This final choice turned out to be the most significant for developments in e-MID. Regarding the 5th crisis sub-period, note that very often a certain time-lag elapses after the default of an institution before other banks start experiencing difficulties (most notably due to the time necessary to start insolvency procedures). This is one additional reason why the dummy starting on 29 September turns out to be more relevant in terms of the impact on the market than a dummy taking value one from 16 September (i.e. the date soon after the default of Lehman).

¹³ F. Partnoy, *The derivatives vacuum*, Financial Times, August 9, 2007.

¹⁴ This approach requires to specify the maximum lag (or truncation parameter) which determines the weight attached to each covariance – such weight is largest for adjacent observations, declines as the distance between observations increases, and grows to one asymptotically. The parameter is chosen by inspecting the autocorrelogram of the residuals, trying alternative values to make sure results are not sensitive to the choice.

effect in the data. On the other hand, the time effect seems to be negligible (i.e. White standard errors are almost equal to standard errors clustered by time). This is most likely due to the availability on the right-hand side of estimated equations of a large number of daily-dummies and regressors that allow to control for the dependence in the cross-section, i.e. for those unobserved time effects that cause the residuals of each day t to be correlated across different banks. A possible sample selection problem is addressed directly in Section 6.

3.2 The Eurosystem's operational framework

Within the unsecured money markets, which cover maturities from one day to one year, the O/N segment allegedly works in a more mechanic and less information-driven way. Market participants typically access it to smoothly absorb short term liquidity shocks and to adjust their day-to-day cash imbalances. In the euro area the behaviour of credit institutions is directly affected by the rules and practices of the Eurosystem's operational framework – refinancing operations with the ECB, standing facilities and reserve requirements – designed for the implementation of monetary policy. The ECB is the monopoly supplier of the monetary base; refinancing operations with the ECB against collateral are the first option and provide credit institutions with the bulk of liquidity. Besides regular operations, the Eurosystem also offers standing facilities on a daily basis, at penalty rates, to provide or absorb O/N liquidity. These are meant to allow banks to deal with end-of-day balances in a smooth manner and to cushion transitory liquidity shocks. However, only 1967 out of 6297 banks are eligible for regular refinancing with the ECB. Moreover, banks need to actively manage their short-term liquidity shortages as well as to minimize the opportunity cost of holding excess money balances. This is why a secondary market for liquidity has developed among banks, in which the ECB's refinancing is redistributed or withheld by market participants.

By virtue of its monopoly, the ECB can set the conditions at which banks borrow from the central bank and, therefore, it can also influence the conditions at which banks trade with each other in the money market. In its operations the ECB aims to ensure a proper functioning of the market. The most important guiding principle of the operational framework is the operational efficiency, defined as *“the capacity of the operational framework to enable monetary policy decisions to feed through as precisely and as fast as possible to short-term money market rates”*.¹⁵

4. Operational efficiency of the ECB's monetary policy implementation

To investigate whether monetary policy decisions fed through to overnight rates (i) precisely and (ii) quickly during the crisis, I quantify the ceteris paribus impact of market events on:

¹⁵ For a complete description of the operational framework, see ECB (2006).

- (i) the average spread over the policy rate, i.e. the basis points (bps) difference between the daily average market price for O/N funds in e-MID and the policy rate set by the ECB (i.e. the minimum bid rate in main refinancing operations);
- (ii) the intraday variability of O/N interest rates, measured by the intraday standard deviation of interbank rates in e-MID.¹⁶

Figure 4 (left side) plots the daily time series of the weighted average O/N rate in e-MID, the policy rate and, correspondingly, the spread between the two from 2 January 2007 until end-November 2008. Figure 4 (right side) plots the intraday variability of O/N rates in e-MID. Two key elements emerge from these plots. First, while being on average liquidity-short before the start of the crisis, the system became on average liquidity-long after 9 August 2007, and this liquidity surplus exerted a downward pressure on the average O/N rate (hence on the spread). Second, although the highest spike of intraday variability occurred before the start of the crisis (in March 2007), the dispersion in the cross-section became notably higher since 9 August 2007. Clearly, the market enters a new phase after 25 September 2008: the spread slides several bps below zero and O/N rates become much more volatile.

Figure 4: The spread over the policy rate and its intraday variability in the e-MID market

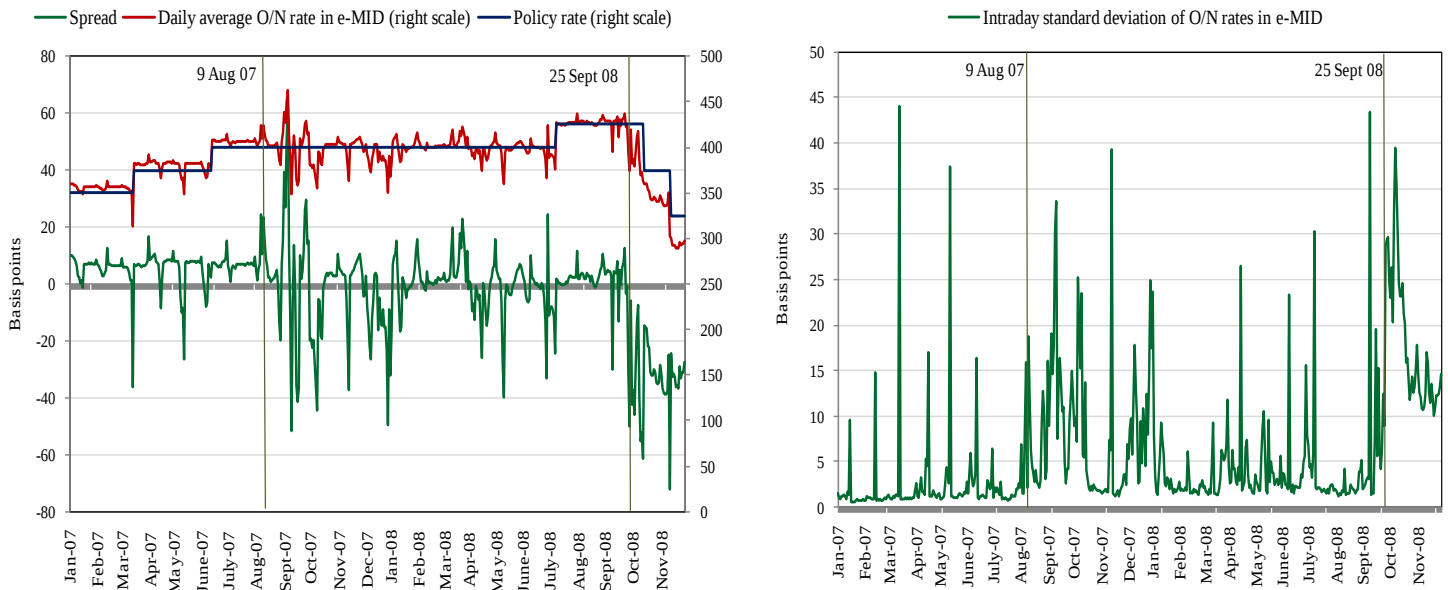


Table 1 reports the results of the following regressions:

$$s_t = \alpha + \beta'_{crisis} D_t + \delta' Z_t + \gamma' C_t + \epsilon_t$$

$$sd_t = \alpha + \beta'_{crisis} D_t + \delta' Z_t + \gamma' C_t + \epsilon_t$$

¹⁶ This empirical analysis moves from Furfine's (2002) paper on the functioning of the Fed Funds market during 1998, and adapts it to specific features of the 2007-2008 financial crisis and of the Eurosystem's operational framework.

where $s_t = \frac{\sum_{j=1}^J (p_{jt} - r_t) w_{jt}}{\sum_{j=1}^J w_{jt}}$ is the average spread over the policy rate in day t (with each intraday difference between the price paid for the j^{th} loan and the policy rate, $p_{jt} - r_t$, weighted by the amount borrowed, w_{jt}); $sd_t = \sqrt{\frac{1}{J} \sum_{j=1}^J (p_{jt} - \bar{p}_t)^2}$ is the intraday standard deviation of the prices paid for O/N loans traded in day t ; D_t is the 5×1 vector of sub-period crisis-dummies defined in Section 3.2; Z_t is a vector of time-varying factors that affect the interbank market in general and the overnight segment in particular, and C_t includes a set of time dummies to control for the influence of the Eurosystem's operational framework on the dynamics of the market, for seasonal and calendar-related movements and for the ECB's exceptional interventions during the financial crisis (these variables and time dummies are described in detail in Table 4). β_{crisis} is the vector of estimates that measure the average impact of the market events chosen as crisis breakpoints on the dynamics of the spread and of the intraday variability of O/N rates.¹⁷

In Table 1 the spread between the average e-MID rate and the policy rate is significantly different compared to normal times only after the capital injection by the Swiss Government into UBS (third crisis sub-period) and after the bailout of many European commercial banks at the end of September 2008 (fifth sub-period). That is, once we control for changes in perceived counterparty credit risk, changes in the amount of refinancing provided by the ECB – hence in banks' desire to hoard surplus reserves¹⁸, ECB's exceptional liquidity provision and seasonal and calendar movements, we see that the market events chosen as breakpoints do not have a strong impact on the O/N spread. In particular, the spread does not increase following such events but declines, most notably after 29 September 2008. On the other hand, notwithstanding the controls included in the analysis, market events seem to have a remarkable effect on the intraday variability of interest rates. The cross-section dispersion of the prices paid for O/N loans is 2 bps higher immediately after the default of Bear Stearns's hedge funds, 5.5 bps higher after 9 August 2007, and 8.5 bps higher after 29 September 2008.

Interestingly, a unit increase in the iTraxx index increases the average daily spread by 0.07 bps, while it does not have an impact on intraday variability. As expected, ampler liquidity conditions in the market – as proxied by the EONIA volumes – result in lower spreads in e-MID. The almost perfect correlation throughout the sample period between the amount of refinancing provided by the Eurosystem and the amount of reserves that banks deposited with CBs suggests that the ECB's

¹⁷ Note that these regressions do not consider a structural approach. A detailed modeling of the O/N interest spread, such as in Linzert and Schmidt (2008), Würtz (2003) or Benito et al. (2007), would consider the determinants of liquidity supply, i.e. the ECB's forecasts of banks' refinancing needs, and is beyond the scope of this paper. The aim here is to provide evidence on the impact of crisis events on the variables that are of relevance from the point of view of an "operationally efficient" implementation of the monetary policy stance, disentangling such impact from seasonal and regular market patterns.

¹⁸ There is an almost perfect correlation throughout the sample period between the total amounts of refinancing outstanding and the amounts of reserves that banks deposited with the Eurosystem. In order to avoid collinearity only the total amount of reserves has been included on the right-hand side of the equations.

liquidity interventions had a role in crowding out a part of private trading activity in the secondary market. Therefore, the aggregate effect of a looser liquidity provision by the ECB, banks' hoarding of surplus liquidity and, possibly, a lower demand for funds in the secondary market explains the downward pressure on the interbank spread. In economic terms, each extra EUR billion of liquidity traded by the EONIA banks implies a 0.2 bps reduction in the spread; a billion increase in the reserves deposited at CBs or in the recourse to the deposit facility implies a 0.1 bps reduction; each extra billion absorbed at FTOs corresponds to a 0.1 bps lower spread. As regards the marginal tender rate at MROs, the latter is on average negatively correlated with the average daily e-MID rate. This result seems counterintuitive, since one would expect a positive correlation between the marginal bid rate at the ECB's repo auctions and the price paid for loans in the secondary market. One possible explanation is the increased uncertainty about other banks' (as well as about its own) liquidity condition. Increased liquidity uncertainty, together with the increased attractiveness of the ECB's tender operations due to its collateral framework, might have induced banks to bid more aggressively at the auctions to avoid being rationed at the marginal rate (see Eisenschmidt et al., 2009). This in turn resulted in an overall lower demand for liquidity in the secondary market, hence an additional downward pressure on the O/N rate. Furthermore, the fact that the largest widening of the spread occurred after 29 September 2008 might to some extent be driven by the relevant changes to the operational framework (i.e., the narrowing of the interest rates' corridor and the provision of unlimited liquidity at a fixed rate in MROs and LTROs) and their influence on institutions' incentives to lend excess liquidity in the market.¹⁹

Finally, note that in the days of allotment of regular FTOs before the start of the crisis there is no significant movement of O/N rates, nor of their intraday dispersion (in the current implementation framework FTOs are regularly allotted to ease liquidity tensions that materialise at the end of reserve maintenance periods – tensions that actually show up in the notable 14 bps spike in interest rates' variability documented in the right-hand part of Table 1). The allotment of supplementary FTOs since 9 August 2007, instead, corresponds to a 5.4 bps increase in the intraday dispersion of O/N prices, which could reflect different degrees of liquidity imbalance of e-MID borrowers and/or the exploitation of some market power by banks that managed to borrow at those supplementary auctions.²⁰ The results also show the strong economic and statistical significance of calendar and seasonal factors to explain daily average O/N rates. The estimates are robust to alternative ARCH/GARCH specifications for the error term.

¹⁹ Such influence has been confirmed by talks with the treasurers of some European banks. As to another indirect effect, the operational changes may have induced banks to front-load their reserve holdings (or heightened such a tendency), thus contributing to a reduction in the spread.

²⁰ FTOs regularly take place on the last day of the reserve maintenance period to counter the liquidity imbalance showed in the ECB's forecasts. Starting from 9 August 2007 the ECB allotted "supplementary" FTOs and LTROs. While the allotment of supplementary LTROs (3 and 6 months maturity) did not have an immediate impact on the O/N spread nor on rates variability (as expected), the coefficient on the dummy controlling for supplementary (overnight maturity) fine-tuning sheds light on the immediate impact of these exceptional operations on O/N rates.

Table 1: The operational efficiency of monetary policy implementation

Dependent variables	Average spread over policy rate (s_t)		Intraday variability (sd_t)	
	Estimated impact of crisis events (in basis points, relative to the average in Jan-July 2007)			
Crisis sub-periods:				
(1) 31 July 2007 – 8 Aug 2007	1.295	(2.34)	2.075 ***	(0.71)
(2) 9 Aug 2007 – 1 Oct 2007	0.570	(4.02)	5.493 ***	(1.77)
(3) 2 Oct 2007 – 13 Mar 2008	-5.474 *	(3.23)	-0.254	(1.15)
(4) 14 Mar 2008 – 26 Sept 2008	-5.455	(3.42)	-0.518	(1.30)
(5) 29 Sept 2008 – 28 Nov 2008	-26.797 **	(11.21)	8.547 ***	(3.22)
Z_t				
iTraxx Index	0.069 ***	(0.03)	-0.012	(0.01)
Eonia volumes	-0.204 ***	(0.00)	0.090 ***	(0.00)
Total reserves deposited at CBs	-0.098 *	(0.00)	0.030 **	(0.00)
Amount allotted at liq. absorbing FTOs	-0.097 ***	(0.00)	0.007	(0.00)
Recourse to ML	0.377	(0.00)	0.171 *	(0.00)
Recourse to DF	-0.112 ***	(0.00)	0.024 **	(0.00)
Marginal tender rate – minimum bid rate at MROs	-0.305 **	(0.13)	0.231 ***	(0.04)
C_t				
End of reserve maintenance periods	-3.098	(4.79)	14.402 ***	(3.34)
End of months/quarters/year	2.371 *	(1.38)	0.858 *	(0.50)
Days before and after TARGET holidays	6.217 **	(2.48)	1.081	(1.19)
Italian national holidays	2.375 *	(1.34)	-1.074	(1.06)
Days of allotment of regular FTOs	-7.551	(7.54)	4.271	(6.13)
Days of allotment of supplementary FTOs since 9 Aug 2007	-3.542	(2.92)	5.416 ***	(1.89)
Days of allotment of MROs	0.254	(0.92)	-0.240	(0.33)
Thursdays of ECB’s press conferences	-4.659 ***	(1.71)	0.728 *	(0.40)
Days of other exceptional crisis-related interventions by the ECB	8.378	(6.54)	2.873	(3.07)
R^2	0.58		0.69	
Obs.	490		490	

Note: The estimation sample consists of daily data from 2 January 2007 until 28 November 2008. Interest rates outside the corridor determined by the Eurosystem standing facilities (i.e. prices 100 bps above or below the policy rate) have been filtered out. Volume-variables are in EUR billion; price variables in basis points. The standard errors (reported in parentheses) are estimated using Newey-West heteroskedasticity and autocorrelation consistent estimators. One, two or three asterisks denote significance at 10, 5 and 1 percent confidence levels, respectively.

5. Impact of the crisis on e-MID market turnover

As documented in Figure 3, O/N volumes traded by the EONIA panel banks were on average higher during the second half of 2007 and throughout 2008 compared to the period before the breakout of the crisis; until the sudden decline after 29 September 2008. On the other hand, e-MID turnover has contracted steadily since the outbreak of financial tensions. In order to shed light on the extent to which the decline of e-MID volumes during the crisis was led by market events rather than (i) by the ECB becoming the main supplier of liquidity to market participants through its liquidity injections and (ii) by banks' desire to hoard liquidity, I estimate the following regressions:

$$\ln(vol_t) = \alpha + \beta'_{crisis} D_t + \delta' Z_t + \gamma' C_t + \epsilon_t$$

$$\ln(netvol_t) = \alpha + \beta'_{crisis} D_t + \delta' Z_t + \gamma' C_t + \epsilon_t$$

where vol_t is the aggregate volume of O/N loans traded in e-MID in day t ; $netvol_t$ is the aggregate daily net volume, i.e. for banks that both borrowed and lent on any given day only the net amount borrowed is considered²¹; D_t is the 5x1 vector of sub-period crisis dummies; Z_t and C_t are defined as in the regressions for the spread and the intraday standard deviation presented in the previous section (see the detailed description in Table 4).

The results on the left-hand side of Table 2 show that the market events chosen as crisis breakpoints did have a strong negative impact on the turnover of e-MID. Interestingly, the (*ceteris paribus*) strongest reduction relative to pre-crisis times did not occur after 29 September 2008 (fifth crisis sub-period) but after the quasi-default of Bear Stearns in March 2008 (fourth sub-period). Among the time-varying factors included in Z_t a unit increase in the iTraxx index corresponds to a 0.17% reduction in traded volumes; larger amounts of funds traded by the EONIA panel banks, a higher hoarding of liquidity (as indicated by larger amounts of reserves deposited at CBs or by a higher recourse to the deposit facility) as well as larger amounts absorbed at FTOs, all correspond to a statistically significant decrease in e-MID turnover – although rather small in economic terms. Economically more sizeable are instead some seasonal effects, and in particular those related to the end of months/quarters/years and to the Italian national holidays.²²

The results in the central column of Table 2 are meant to confirm that the reduction in gross market turnover actually represented a reduced reallocation of banking system's reserves in e-MID and not, instead, a lower intermediation activity by large dealer banks. In the latter case we should not observe the same significant decline when considering net traded volumes; and this difference would indicate that the relevant decrease of gross market turnover is simply a reflection of large banks' perception that dealing by entering the market on both the borrowing and the lending side was not as profitable in crisis times as it was before the start of the turmoil. Clearly, the evidence in Table 2 points to the absence of large dealer intermediaries in e-MID (see also Iori et al., 2008).

²¹ Banks that were net sellers of funds were treated as zeros. Notice that I did not include any time trend as there is no clear evidence that the size of the market was growing or decreasing during the first half of 2007.

²² Note that market activity typically peaks in e-MID around the end of reserve maintenance periods, in the days of allotment of MROs, and at the end of a month/quarter/year due to banks' heightened sensitivity to liquidity developments in these specific days, either because banks face larger payments or because the minimum reserve constraint eventually becomes binding (see Beaupain and Durré, 2008). These regular market patterns of traded volumes have apparently been more than offset by the reduction in e-MID trading activity.

Table 2: The impact of the crisis on the e-MID market turnover

Dependent variables	Log of gross daily volumes ($\ln(vol_t)$)	Log of net daily volumes ($\ln(netvol_t)$)	Log of gross daily volumes ($\ln(vol_t)$)
	Estimated impact of crisis events (in percentage pts, relative to the average in Jan-July 2007)		
Crisis sub-periods:			
(1) 31 July 2007 – 8 Aug 2007	-21.75 *** (0.05)	-25.02 *** (0.05)	-20.53 *** (0.05)
(2) 9 Aug 2007 – 1 Oct 2007	-27.40 *** (0.07)	-28.88 *** (0.08)	-14.62 ** (0.07)
(3) 2 Oct 2007 – 13 Mar 2008	-33.43 *** (0.06)	-33.79 *** (0.06)	-5.75 (0.10)
(4) 14 Mar 2008 – 26 Sept 2008	-39.62 *** (0.07)	-40.88 *** (0.07)	-9.86 (0.11)
(5) 29 Sept 2008 – 28 Nov 2008	-24.66 ** (0.14)	-25.44 ** (0.14)	41.06 (0.22)
Z_t			
iTraxx Index	-0.17 *** (0.00)	-0.14 ** (0.00)	-0.16 *** (0.00)
Eonia volumes	0.69 *** (0.00)	0.67 *** (0.00)	0.78 *** (0.00)
Total reserves held with CBs	-0.15 *** (0.00)	-0.14 *** (0.00)	-0.20 ** (0.00)
Amount allotted at liq. absorbing FTOs	-0.15 *** (0.00)	-0.13 ** (0.00)	-0.22 *** (0.00)
Amount allotted at MROs	-	-	0.10 (0.00)
Amount allotted at LTROs	-	-	-0.20 ** (0.00)
Recourse to ML	-0.40 (0.00)	-0.67 * (0.00)	-0.44 (0.00)
Recourse to DF	-0.21 *** (0.00)	-0.20 *** (0.00)	-0.20 ** (0.00)
Marginal tender rate – minimum bid rate at MROs	0.12 (0.00)	0.13 (0.00)	0.41 ** (0.00)
C_t			
End of reserve maintenance periods	0.62 (0.05)	-6.76 (0.06)	1.54 (0.05)
End of months/quarters/year	-12.09 *** (0.03)	-13.08 *** (0.03)	-12.63 *** (0.03)
Days before and after TARGET holidays	6.83 (0.05)	4.42 (0.05)	2.81 (0.06)
Italian national holidays	-13.26 * (0.08)	-11.80 * (0.07)	-14.21 ** (0.07)
Days of allotment of regular FTOs	-10.28 (0.07)	-11.40 * (0.06)	-10.20 (0.07)
Days of allotment of supplementary FTOs since 9 Aug 2007	8.54 (0.07)	6.37 (0.07)	6.40 (0.06)
Days of allotment of MROs	-1.06 (0.02)	0.50 (0.02)	-1.69 (0.02)
Days of allotment of regular LTROs	-	-	-3.38 (0.09)
Days of allotment of supplementary LTROs since August 2007	-	-	-6.98 * (0.04)
Thursdays of ECB's press conferences	0.81 (0.04)	-0.71 (0.04)	2.09 (0.04)
Days of other exceptional crisis-related interventions by the ECB	5.18 (0.05)	4.50 (0.06)	4.49 (0.06)
R ²	0.75	0.74	0.77
Obs.	490	490	490

Note: The estimation sample consists of daily data from 2 January 2007 until 28 November 2008. The table reports the impact of each crisis sub-period dummy and of unit changes in time-varying regressors in percentage points relative to non-crisis times. The standard errors (reported in parentheses) are estimated using Newey-West heteroskedasticity and autocorrelation consistent estimators. One, two or three asterisks denote significance at 10, 5 and 1 percent confidence levels, respectively.

Finally, on the right-hand side of Table 2 I report the results of a regression where the gross market turnover is the dependent variable and where I included among the regressors in Z_t the amounts allotted at MROs and LTROs, and in C_t two time dummies taking value one respectively in the days of allotment of regular 3-months LTROs (i.e. those allotted based on the published indicative calendar) and in the days of supplementary 3 and 6-months LTROs allotted by the ECB since August 2007. While the availability of longer-term refinancing should not matter for the O/N

maturity (and in fact it does not in the regressions for the spread nor for the intraday variability of interbank rates), it turns out to be significant to explain lower volumes in e-MID during the crisis. For instance, according to the estimates, a 1 billion increase in the funds auctioned at LTROs reduces O/N volumes by 0.21% relative to the first half of 2007. Furthermore, while the allotment of regular LTROs before the crisis does not have an impact on traded volumes, the allotment of supplementary operations since 22 August 2007 captures a sizable 7% decrease in O/N turnover. Besides, it is interesting to note that the statistical significance of these coefficients takes away significance to most of the crisis dummies. As a last remark, seasonal factors such as the end of months, quarters, or the end of the year, and the Italian national holidays, account for relatively large declines in turnover in all the specifications.

6. Impact of the crisis on institutions' borrowing costs

In this section I look at the prices paid by e-MID participants to borrow O/N funds during the crisis relative to their funding costs in the period from January to July 2007. In particular, I am interested in testing whether bank size, nationality, reputation, frequency of trading and pre-crisis riskiness are significant determinants of banks' borrowing costs in the various crisis sub-periods. Using panel data from January 2007 to November 2008 I estimate the following equation:

$$s_{it} = \alpha + \beta'X_{it} + \zeta'X_{it} \iota'D_t + \eta'D_t risk_i + \delta'Z_t + \gamma'C_t + \epsilon_{it}$$

where s_{it} is the (volume-weighted) average interest rate spread paid by bank i in day t , that is:

$$s_{it} = \frac{\sum_{j=1}^J (p_{ijt} - r_t) w_{ijt}}{\sum_{j=1}^J w_{ijt}}$$

where p_{ijt} denotes the interest rate paid by bank i on loan j in day t , r_t denotes the policy rate, w_{ijt} is the amount borrowed via the j^{th} loan, and J denotes the total number of loans exchanged by bank i in day t ;²³ X_{it} is a vector of bank-specific variables including measures of bank size, bank reputation, frequency of trading activity and a dummy for bank nationality; D_t is the 5x1 vector of sub-period crisis dummies; $risk_i$ is a proxy for the riskiness of bank i in normal times (built using interest rate spreads paid for O/N loans in 2006); Z_t and C_t include the variables discussed in the previous sections and described in detail in Table 4 (see Table 4 also for the description of the vector X_{it} and of $risk_i$).

Differences in risk are certainly important to explain the cross-section variation of interest rates paid for uncollateralised funds (see Furfine, 2001, and Cocco et al., 2008). Given that the identity of the banks is unknown to me, I elicit a bank's perceived market riskiness ($risk_i$) from the rates the bank

²³ An alternative definition of the spread has been used, where s_{it} is a weighted average of the spreads between prices paid by bank i on overnight loans obtained in day t and the average price at which the market was trading in the corresponding 10' time interval. However, the definition reported in text was deemed more appropriate for the analysis.

used to pay to borrow O/N funds in e-MID during normal times (and before 2007). Therefore the coefficient estimates of $\hat{\eta}$ are meant to provide evidence as of whether institutions perceived as riskier by the market in normal times did actually pay higher spreads during the crisis.²⁴ Furfine (2001) finds that, beyond differences in risk, bank size and counterparty relationships may also be important determinants of the price of a federal funds loan. Relationships should not be relevant on the electronic platform, where each participant faces identical search costs, while bank reputation is expected to matter given the transparency of the trading mode. Bank size (measured by a bank's daily turnover in the e-MID market) might have played a role especially after the start of financial tensions, as a consequence of a too-big-to-fail insurance implicitly granted by Governments to the banks with the highest volumes of business. Bank nationality is not expected to matter in normal times, given the high efficiency and integration of the euro money market. However, a retrenchment towards national counterparties is a possible outcome in a context of higher credit/liquidity risk, and higher uncertainty about the willingness/possibility of a counterparty to roll over a loan that matures the next day.²⁵

The results reported in Table 3 confirm the guess that in normal times banks with a stronger reputation – that is, banks that manage to borrow mostly by posting bid quotes (i.e. requesting a certain amount of liquidity at a given price) rather than by accepting lenders' offers – enjoy on average better funding conditions. At the same time, being bigger does not reduce significantly the price of O/N loans. This changes remarkably after the start of the crisis: for each additional EUR billion traded in the market in a given day banks get, *ceteris paribus*, a discount of almost 5 bps after 31 July 2007, of additional 1.8 bps after the rescue of Bear Stearns in March 2008, and of extra 5 bps after the bailout of many large European banks after 29 September 2008.²⁶ This could be a reflection of an implicit too-big-to-fail guarantee. In fact, the effect is stronger in the last crisis sub-period, i.e. when European governments were forced to make explicit the promise that no other systemically important financial institution would be allowed to fail.

As expected, bank nationality is not significant to explain e-MID rates in the first half of 2007. However, it seems that foreign banks paid significantly higher rates on the platform compared to Italian ones soon after the tensions related to the bankruptcy of Bear Stearns' hedge funds at the end of July 2007 and, more remarkably, after the definitive spread out of the crisis to EU banks at the end of September 2008. Indeed, in a context of higher uncertainty – not least regarding the applicable

²⁴ In particular, a coefficient estimate of one would mean that a bank that used to pay a one basis point higher spread in 2006 (or, for banks that started to trade in e-MID in 2007, a one basis point higher spread in the first half of 2007) would be paying an additional basis point during the crisis sub-period for which the interacted dummy is statistically significant.

²⁵ The 2006 euro money market survey, conducted on a sample of 158 banks operating in the euro area, reports that bank treasurers tend to vary their approach towards funding depending on: their strategy, the type of bank (e.g. commercial versus investment), the market eligibility of available collateral, their level of activity, capital cost considerations (Basel II), and the respective prices of alternative sources of funding.

²⁶ As an alternative measure of bank size I used a bank's daily share of market turnover. The results are overall identical.

insolvency procedures when operating across national borders, as the default of Lehman Brothers has revealed – banks might prefer national trading counterparties.

The proxy for bank reputation suggests that banks able to borrow by posting their bids for O/N liquidity enjoyed significantly lower funding costs since 9 August 2007 and throughout the crisis, with a pick achieved after 29 September 2008 when banks with a stronger reputation enjoyed almost 24 bps discount compared to the spread they used to pay in normal times.²⁷ Borrowing liquidity via a higher number of loans is more costly in e-MID in normal times, and this cost escalates at the start of financial tensions (passing from an approximate 0.05 bps increase for each additional loan traded in the market before the crisis, to a 0.40 bps increase in the first two crisis sub-periods).²⁸ Regarding the impact of banks' riskiness, the coefficients on the crisis dummies interacted with the variable *risk_i* suggest that after the start of tensions (in the sub-period from 9 August until the start of October 2007) banks perceived as riskier in normal times were actually paying higher prices for O/N loans. This effect is not statistically significant for the other sub-periods, which suggests that banks deemed riskier by the market during the crisis were not those perceived to be riskier in normal times.

The central column of Table 3 shows that, if we include bank fixed effects in the estimation, we get that in normal times higher volumes of business correspond to higher prices of O/N loans, while the proxy for reputation loses statistical significance. As regards the additional effect of size during the crisis, its statistical significance is weaker and the economic magnitude lower (when including bank fixed effects the coefficients become 3 and 1.5 times lower after the quasi-default of Bear Stearns and after the bailout of large EU banks, respectively). Altogether, this seems to suggest that the effect of size on borrowing rates is mostly specific to individual banks trading in e-MID. Finally, regarding the market-wide controls included in Z_t , the iTraxx is highly significant in all the specifications, and captures a 0.07 average increase in the spread.²⁹

²⁷ Note that here we refer only to loans that were actually traded on the platform. Unfortunately, we cannot observe the bids that did not match any willing lender, so as to see a possible rationing of certain credit institutions in the market.

²⁸ The regressor *numloans_{it}* is in fact a normalized measure, where the daily number of loans traded by bank *i* in day *t* is divided by the number of banks with which bank *i* could have traded in that day in the market. Table 3 does not report the raw coefficient estimates, but the impact on the spread in bps (calculated so as to take into account the normalisation).

²⁹ Among the other controls included in the regressions the stronger determinants of O/N rates are the time dummies accounting for seasonal and calendar-related patterns. Specifically: the days immediately before and after the closure of TARGET, when the spread increases by almost 7 bps; the end of months/quarters/year, when the spread increases by 4 bps; the Thursdays of the ECB's press conferences and the days of regular allotment of FTOs, when the spread goes down by approx. 5 and 4 bps, respectively; the days when the ECB announced its exceptional interventions to tackle the crisis (such as changes to the Eurosystem's operational framework) when the spread increased by more than 7 bps.

Table 3: The impact of the crisis on banks' cost of overnight funding

Dependent variable	Average daily spread (s_{it}) ^a		Average daily spread (s_{it}) ^b		Average daily spread (s_{it}) ^c	
	Estimated impact of bank variables before and throughout the crisis (in basis pts, relative to the average in Jan-July 2007)					
Bank specific variables - X_{it}						
Size _{it}	-0.054	(0.00)	0.836 ***	(0.00)	-0.320	(0.00)
Nationality _i	0.337	(0.54)	-		1.441	(1.58)
Reputation _{it}	-2.153 ***	(0.47)	0.346	(0.50)	-1.846***	(0.53)
Numloans _{it}	0.048 *	(3.46)	0.044	(5.42)	0.058*	(4.04)
Bank variables interacted with sub-period crisis dummies - $X_{it} \text{ ' } D_t$						
Size _{it} xD ₁	-4.464 **	(0.00)	-4.317 **	(0.00)	-5.420***	(0.00)
Size _{it} xD ₂	-0.903	(0.00)	-1.371	(0.00)	-3.573**	(0.00)
Size _{it} xD ₃	-0.709	(0.00)	0.154	(0.00)	-0.336	(0.00)
Size _{it} xD ₄	-1.827 ***	(0.00)	-0.614 *	(0.00)	-1.946***	(0.00)
Size _{it} xD ₅	-5.000 ***	(0.00)	-3.491 **	(0.00)	-6.381***	(0.00)
Nationality _t xD ₁	4.304 **	(1.88)	3.779 **	(1.65)	5.516***	(1.72)
Nationality _t xD ₂	-3.741	(2.41)	-2.176	(2.35)	1.426	(3.90)
Nationality _t xD ₃	-0.705	(0.69)	-0.819	(0.76)	-1.234	(1.43)
Nationality _t xD ₄	-0.511	(0.70)	-0.412	(0.64)	0.928	(1.24)
Nationality _t xD ₅	14.273 ***	(4.40)	13.053 ***	(4.35)	20.363***	(5.20)
Reputation _{it} xD ₁	-1.209	(1.45)	-0.171	(1.37)	-3.363**	(1.36)
Reputation _{it} xD ₂	-12.312 ***	(2.49)	-12.912 ***	(2.42)	-15.906***	(1.54)
Reputation _{it} xD ₃	-6.491 ***	(0.59)	-6.493 ***	(0.55)	-7.173***	(0.67)
Reputation _{it} xD ₄	-5.045 ***	(0.57)	-5.788 ***	(0.67)	-5.736***	(0.74)
Reputation _{it} xD ₅	-23.813 ***	(3.00)	-27.074 ***	(3.02)	-24.661***	(3.83)
Numloans _{it} xD ₁	0.426 ***	(14.46)	0.403 ***	(13.11)	0.412***	(13.33)
Numloans _{it} xD ₂	0.336 ***	(12.55)	0.452 ***	(13.28)	0.303***	(11.04)
Numloans _{it} xD ₃	0.040	(3.64)	0.050	(4.78)	0.027	(4.10)
Numloans _{it} xD ₄	-0.037	(6.04)	0.024	(5.10)	-0.010	(5.30)
Numloans _{it} xD ₅	0.012	(21.25)	-0.022	(21.03)	-0.212	(20.84)
Risk _i xD ₁	0.119	(0.17)	-0.136	(0.15)	0.301**	(0.13)
Risk _i xD ₂	1.028 ***	(0.36)	0.879 ***	(0.33)	1.481***	(0.18)
Risk _i xD ₃	0.036	(0.07)	-0.214 **	(0.08)	0.036	(0.08)
Risk _i xD ₄	0.052	(0.08)	-0.316 **	(0.13)	0.050	(0.09)
Risk _i xD ₅	0.134	(0.30)	-0.202	(0.29)	0.424	(0.31)
Z_t						
iTraxx Index	0.074 ***	(0.00)	0.060 ***	(0.01)	0.080***	(0.00)
C_t						
End of months/quarters/year	3.395 ***	(0.20)	4.241 ***	(0.20)	3.616***	(0.22)
Days before and after TARGET holidays	6.826 ***	(0.34)	6.245 ***	(0.34)	6.854***	(0.41)
Italian national holidays	2.450 ***	(0.22)	3.261 ***	(0.23)	2.490***	(0.22)
Days of allotment of regular FTOs	-4.081 ***	(1.25)	-8.003 ***	(1.21)	-4.420***	(1.38)
Thursdays of ECB's press conferences	-5.122 ***	(0.20)	-3.172 ***	(0.19)	-4.926***	(0.21)
Days of other exceptional crisis-related interventions by the ECB	7.385 ***	(0.90)	2.275 ***	(0.86)	7.133***	(0.93)
Number of borrowing banks	136		136		63	
R ²	0.48		0.50		0.52	
Obs.	25,454		25,454		18,109	

Note: ^(a) OLS regression; ^(b) Within regression. In both estimations standard errors are heteroskedasticity-robust and adjusted for 136 clusters (reported in parenthesis to the right of each coefficient). Banks that traded in less than the 10th percentile of the business days in each year (i.e. in less than 14 days in 2006-07 and in less than 13 days in 2008) are excluded from the sample. ^(c) OLS regression with White standard errors adjusted for 63 clusters. The analysis is based on daily data from 2 January 2007 until 28 November 2008. The dummy D_j refers to the j^{th} crisis sub-period. Only some of the controls included on the right-hand side are reported in the table (complete results are available upon request). One, two and three asterisks denote statistical significance at 10, 5 and 1 percent level, respectively.

The decline in market turnover and in the number of banks trading regularly in e-MID since the start of the crisis, and especially after the end of September 2008, does not allow to exclude a sample selection problem. That is, the results could in fact be driven by unobserved factors included in the error term that in turn drive banks' selection into the sample in any given day. Such a sample selection issue would affect the consistency and asymptotic normality of the OLS as well as of the within estimator, thus casting doubt on the outcome of the estimation. To tackle this issue, I re-ran the analysis by restricting the sample to those banks that traded in at least the median number of business days in each of the 3 years under analysis, i.e. in at least 127 out of 254 business days in 2006 and 2007 and in at least 117 business days in 2008. While this reduces significantly the number of units in the cross section and, consequently, the number of observations available (from 134 to 63 banks and from 25,454 to 18,109 observations) it also minimises the potential for sample selection bias. As shown in the column on the right of Table 3 the results are robust (unique valuable differences compared to the results reported on the left side of the table are italicised).

All in all, financial tensions that set off in the euro money market after end-July 2007 affected significantly banks' funding costs also in the shortest maturity bucket. In particular, the analysis documents the retrenchment of Italian banks towards national trading counterparties in a market previously perceived as extremely well integrated, and the price-benefit enjoyed by the banks with the highest volumes of business in times of increased liquidity and credit uncertainty.

7. Conclusions

This paper provides a detailed analysis of the functioning of the O/N unsecured euro money market by looking at the time patterns of aggregate interest rates, market turnover and individual banks' borrowing costs in e-MID during the 2007-2008 financial crisis. The analysis tries to disentangle the impact of crisis events from seasonal patterns of market activity, movements determined by the Eurosystem's operational framework, the impact of the ECB's exceptional crisis-related interventions.

Although perceived as extremely efficient and integrated before the start of the crisis, the O/N segment was not immune to the dislocations that affected the term segments of the unsecured money market since August 2007. In particular, the analysis presented in this paper studies the impact of different crisis events on the operational efficiency of the Eurosystem's monetary implementation and on the turnover of the market. The results show how, alongside crisis events, the additional amounts of refinancing provided by the ECB and credit institutions' higher tendency to hoard surplus reserves have an important role in explaining the realised O/N patterns. Furthermore, higher liquidity uncertainty and the important changes to the operational framework have certainly influenced banks' bidding behaviour in the primary market and, thereafter, banks' incentives to trade in the secondary market. As expected, the increased perception of counterparty credit risk can explain an increase of

daily average O/N rates; seasonal factors are important determinants of the interday dynamics of the spread and of the increase in interest rates volatility both in normal times and in times of crisis.

As regards the significant decrease of the e-MID market turnover since the outbreak of financial tensions, the analysis is consistent with a failure of the market at reallocating excess reserves among its participants. However, the results document that the lower turnover can also be attributed to the ECB crowding out a part of private trading activity in the secondary market. Interestingly, the economic size of the combined effect of a looser liquidity provision by the ECB and a higher hoarding of reserves by banks is not very large compared to the impact of market events as long as we consider only the amounts allotted at MROs and FTOs. However, if we take into account also the increased amounts allotted at supplementary LTROs since August 2007, then the latter are able to capture a decrease in traded volumes of approximately the same size as the decrease attributable to the relevant market events. Importantly, the increased intermediary role of the ECB in the market through its exceptional interventions does not provide sufficient evidence in favour/against the effectiveness of direct liquidity injections as a tool to address systemic liquidity shortages. In fact, while partly crowding out private trading activity, those interventions probably ensured that sound banks were not cut off from financing.

Finally, the section dealing with the impact of the crisis on individual banks' borrowing costs reveals the major role of bank reputation to obtain better funding conditions in e-MID in normal times, and its increased importance after the start of the crisis. This is no surprise given the transparency of the electronic trading mode, since the latter allows banks to maximise the funding potential of their reputation while minimising search costs. At the same time, the results corroborate the existence of a too-big-to-fail guarantee implicitly granted by the market to the banks with the highest volumes of business. In fact, the price benefit enjoyed by banks that are relatively bigger becomes much stronger after 29 September 2008, i.e. when European governments were forced to make explicit the promise that no other systemically important financial institution would be allowed to fail. Another important pattern that comes out of the analysis of banks' borrowing costs concerns the emergence of some market segmentation in e-MID during the crisis. Indeed, in a context of higher uncertainty – not least regarding the applicable insolvency procedures when operating across national borders, as the default of Lehman Brothers has revealed – banks might prefer national trading counterparties.

Overall the results support the focus – in the still ongoing policy debate about how to best redesign the supervisory and regulatory framework of the financial system – on proposals to counteract the effects of moral hazard on the financial system, and on the need to have in place effective resolution regimes especially for large banks operating across national borders.

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Appendix A: Summary statistics of dependent variables and regressors³⁰

Normal times (2 January 2007 – 30 July 2007; 490 business days)

Variables	Mean	Standard deviation	Min	Max	25 th percentile	50 th percentile	75 th percentile
Number of trading banks	128	8	77	146	124	128	132
Number of traded loans	393.5	46.37	196	533	362	386	416
Average spread over the policy rate	5.31	6.29	-36.19	16.86	5.86	6.78	7.69
Intraday variability of interest rates	2.62	5.77	0.55	44.07	0.92	1.17	1.69
e-MID turnover	24.04	5.45	11.63	41.11	20.30	23.22	27.31
iTraxx Europe Senior Financials Index (5 years maturity)	9.25	3.22	7.38	32.00	8.05	8.26	8.64
EONIA turnover	44.61	9.48	25.74	67.55	37.18	44.10	51.45
Amount of Eurosystem's refinancing	433.73	13.48	407.50	465.50	426	431.50	441.50
Amount of reserves deposited with the Eurosystem	183.29	8.16	152.80	205.40	178.75	183.44	188.34
Recourse to Marginal Lending Facility	0.21	0.47	0	2.50	0.001	0.009	0.17
Recourse to Deposit Facility	0.35	0.99	0.01	8.07	0.05	0.09	0.18
Amount allotted at liq. providing FTOs	2.26	0.25	2	2.5	2	2.50	2.50
Amount allotted at liq. absorbing FTOs	7.81	8	2.3	22.5	2.3	2.46	6
Amount allotted at MROs	292.72	15	271.5	330.5	281	288	301.5
Amount allotted at LTROs	141.24	11.54	120	150	130	149.99	150
Spread between marginal and minimum bid rate at MROs	5.90	1.07	3	8	5	6	7

From the start of tensions until the bailout of EU banks (31 July 2007 – 28 September 2008; 298 business days)

Variables	Mean	Standard deviation	Min	Max	25 th percentile	50 th percentile	75 th percentile
Number of trading banks	112	9.5	48	133	108	114	119
Number of traded loans	368.33	59.16	99	553	330	369	404
Average spread over the policy rate	-0.67	13.78	-51.92	62.67	-4.88	1.47	4.57
Intraday variability of interest rates	6.07	6.77	1.14	43.40	1.95	3.04	7.39
e-MID turnover	14.51	3.39	5.39	24.35	12.15	14.07	16.78
iTraxx Europe Senior Financials Index (5 years maturity)	79.58	37.24	27.82	198.93	47.92	72.85	106.17
EONIA turnover	51.99	10.57	17.75	82..34	44.73	52.14	59.26
Amount of Eurosystem's refinancing	453.96	26.91	386	546.50	437.09	454.01	467
Amount of reserves deposited with the Eurosystem	202.74	28.29	122.99	325	189.67	201.55	217.89
Recourse to Marginal Lending Facility	0.26	0.66	0	6.80	0	0.013	0.22
Recourse to Deposit Facility	0.76	2.13	0	28.10	0.16	0.30	0.58
Amount allotted at liq. providing FTOs	37.82	25.71	7.70	94.84	15	40	47.67
Amount allotted at liq. absorbing FTOs	61.38	59.22	8	200	20	29	133.61
Amount allotted at MROs	193.15	50.37	128.50	368.61	161.50	176.50	208
Amount allotted at LTROs	265.94	39.05	150	301	265	268.50	295
Spread between marginal and minimum bid rate at MROs	15.18	6.76	3	48	11	15	18

³⁰ The descriptive statistics in the tables refer to averages of daily data over the indicated sample period. Price variables are reported in basis points; volume variables in EUR billion.

From the bailout of EU banks until the end of November 2008 (29 September 2008 – 28 November 2008;)

Variables	Mean	Standard deviation	Min	Max	25 th percentile	50 th percentile	75 th percentile
Number of trading banks	90	7	76	105	86	90	94
Number of traded loans	277.84	49.55	176	375	247	275	302
Average spread over the policy rate	-33.58	12.77	-72.25	-6.14	-38.44	-32.56	-28.85
Intraday variability of interest rates	18.63	7.71	10.04	39.44	12.36	15.06	24.55
e-MID turnover	8.47	1.51	4.79	11.78	7.49	8.41	9.66
iTraxx Europe Senior Financials Index (5 years maturity)	142.46	24.17	111.80	228.81	126.58	134.96	149.54
EONIA turnover	36.78	7.09	18.65	57.21	31.87	35.74	40.78
Amount of Eurosystem's refinancing	703.94	132.20	410.50	827.70	671.40	753.10	798
Amount of reserves deposited with the Eurosystem	221.80	56.90	152.40	384.90	178.40	199.40	265.50
Recourse to Marginal Lending Facility	10.98	6.71	1.2	24.60	4	12.7	15.50
Recourse to Deposit Facility	168.26	77.16	38.90	297.40	102.80	202.20	218.90
Amount allotted at liq. providing FTOs	24.70	0	24.70	24.70	24.70	24.70	24.70
Amount allotted at liq. absorbing FTOs	163.02	38.64	79.60	200	147.1	173	193.80
Amount allotted at MROs	287.26	56.54	180	338.70	250.90	311.90	335.20
Amount allotted at LTROs	44304	35.98	301	501.80	420.50	447.20	462.80
Spread between marginal and minimum bid rate at MROs	43.17	3.14	40	48	40	45	45

Table 4: Controls and time-varying factors included in the estimated regressions

Right-hand side variables		Description
Market-wide factors affecting in general interbank rates	Z_t	
	$iTraxx_t$	The iTraxx Europe Senior Financials Index (5 years maturity) is based on a basket of CDS of 25 members headquartered in Europe
	$Eoniavol_t$	Daily volumes of O/N loans traded by the 44 banks with the highest volumes of business in the euro zone (forming the EONIA panel) (EUR billion)
Market-specific factors affecting the overnight segment	$totres_t$	Total amount of reserves deposited with the Eurosystem (EUR billion)
	mro_t	Amount allotted at MROs (EUR billion)
	$ltro_t$	Amount allotted at LTROs (EUR billion)
	mlf_t	Recourse to marginal lending facility (EUR billion)
	df_t	Recourse to deposit facility (EUR billion)
	fto_t	Amount allotted at FTOs (EUR billion). Liquidity absorbing and liquidity providing operations are considered separately
	$margmbr_t$	Spread between the marginal tender rate in MRO auctions and the minimum bid rate set by the ECB (basis points)
	$dendRMP_t$	Dummy taking value one in the last day of the Reserve Maintenance Period and zero otherwise

Time-dummies to control for seasonal and calendar-related movements ³¹	C_t	
	$endm_t$	Dummy taking value one in the last 5 days of each month (and hence quarters and years) and zero otherwise
	$target_t$	Dummy taking value one in the day immediately before and the day immediately after a TARGET holiday and zero otherwise
	$nathol_t$	Dummy taking value one in the day immediately before and the day immediately after Italian national holidays and zero otherwise
	$regFTO_t$	Dummy taking value one in the days when FTOs have been regularly implemented before the start of the financial crisis and zero otherwise
	$supplFTO_t$	Dummy taking value one in the days when supplementary FTOs have been implemented starting from 9 August 2007 and zero otherwise
	MRO_t	Dummy taking value one in the days of allotment of weekly MROs and zero otherwise
	$regLTRO_t$	Dummy taking value one in the days of allotment of regular 3-months LTROs before the start of the financial crisis and zero otherwise
	$supplLTRO_t$	Dummy taking value one in the days of allotment of supplementary 3 and 6-months LTROs, allotted starting from 22 August 2007 and zero otherwise ³²
	$ecbpress_t$	Dummy taking value one in the Thursdays of ECB's press conferences
	ecb_t	Dummy taking value one in the days of ECB's crisis-related interventions other than supplementary liquidity injections, e.g. the announcement that the ECB would start offering USD (12 Dec 07), or subsequent changes to EUR-USD swap operations; the coordinated interest rate cut (8 Oct 08); the changes to the implementation framework (switch to a fixed rate-full allotment auction procedure & narrowing of the corridor on 9 Oct 08); the broadening of the list of eligible collateral for refinancing ops (15 Oct 08)
Bank-specific factors	X_{it}	
- Time-constant	$dnat_i$	Dummy variable taking value one for foreign and zero for Italian banks
	$risk_i$	Average price (in bps) paid by bank i for O/N loans before the start of the financial crisis (proxy for a bank's riskiness in normal times) ³³
- Time-varying	$size_{it}$	Total amount traded (i.e. both borrowed and lent) by bank i in day t , proxy for bank size
	$reputation_{it}$	Ratio of buy contracts to the total number of contracts that bank i trades in day t , proxy for bank reputation ³⁴
	$numloans_{it}$	Number of loans traded (on the borrowing and on the lending side) by bank i in day t (normalised by the number of banks with which bank i could have traded in that day in the market)

³¹ These time-dummies allow to control for all those days in which a higher intraday variability and downward/upward spikes of interest rates are regular and predictable (see Beaupain and Durré, 2008).

³² Alternatively, the dates of the announcement of MROs and LTROs have been used. However, the analysis confirms that it is the date of implementation/allotment, i.e. of effective availability of liquidity, that matters for the O/N segment of the money market.

³³ The average spread is computed as a yearly average using 2006 data for banks operating in e-MID already in 2006. For banks that started to operate in e-MID in 2007 $risk_i$ is instead the average spread computed over the first half of 2007.

³⁴ As reported in Section 3.1, banks trading in e-MID can either post a bid quote (price and quantity) demanding O/N liquidity from the market, or an ask quote offering liquidity to other banks. The spreads relating to bid transactions are typically lower than on ask transactions, both for the O/N and for longer term maturities (see e.g. Angelini et al. 2009). This corroborates the importance of bank reputation on the platform, which can be exploited to maximize funding capacity while minimising search and borrowing costs.

Appendix B: Timeline of market events during the 2007-08 financial turmoil

Market events	131 asset backed securities issues are downgraded. Two hedge funds at Bear Stearns' AM are down 19% for the year	Bear Stearns admits it cannot figure out losses due to exposure to the funds. They file for bankruptcy protection at the end of July	BNP Paribas suspends redemptions from 3 money market funds. Extra liq. injections by the ECB and the Fed. Fed extends eligible collateral to mortgage-based paper	Northern Rock is forced to seek liquidity support from BoE, hence precipitating its collapse & eventual nationalization	UBS receives USD 5.3 billion of Gov. injection. USD 5.5 bn is the amount of CDOs of ABS gone into default at end-of-October	November is the worst ever month for CDOs: 2,007 downgrades occur, of which 1,900 affect CDOs of ABS	The amount of CDOs of ABS gone into default reaches USD 45bn. Fed sets up TAF to supply one-month loans to deposit-taking banks
Time	June 2007	18 July 07	9 Aug 07	14 Sept 07	2 Oct 07	Nov 07	17 Dec 07
Soc Gén issues shares for EUR 5.5 bn. Credit Suisse announces USD 2.85 bn in writedowns	Fed unveils TSLF, enabling primary dealers to borrow T-bills for 28 days offering less creditworthy bonds as collateral.	Fed cuts discount rate charged to commercial banks and opens "discount window" to investment firms (first time since the 1930s)	The Fed brokers the rescue of Bear Stearns by JP Morgan Chase. On March 17, the iTraxx EU Financials peaks to 175 points	RBS announces BP 12 bn rights issue	Lehman announces it would seek new capital amid bad rumours about its financial position	Deutsche Bank reports EUR 5 bn of writedowns in the 1 st half of 2008	Allianz sells Dresdner to Commerzbank. The EUR 9bn deal combines Germany's 2 nd & 3 rd largest banks to create a clear domestic rival to Deutsche Bank
19 Feb 08	11 Mar 08		14 Mar 08	21 Apr 08	6 June 08	31 July 08	31 Aug 08

Nationalization of Fannie Mae and Freddie Mac (GSE mortgage lenders). Paulson emphasizes that Fannie and Freddie are <i>unique</i> bodies, deserving special treatment	Lehman Brothers files for bankruptcy. CEO puts Merrill Lynch up for sale, and agrees to be acquired by BoA	Barclays signs deal to acquire Lehman' NA businesses. AIG receives USD 85bn bailout from Gov. HBOS agrees to a takeover by Lloyds TSB (£12 bn deal) & £11.5 bn in Gov funding	Goldman Sachs gives up its status as investment bank. Morgan Stanley follows to access emergency loans	Washington Mutual becomes the largest US bank failure in history. US "Paulson's" plan stalls	Fortis becomes the largest European financial institution to be bailed out. Three Govs throw the bank EUR 11bn lifeline	Hypo Real Estate - one of biggest commercial property & public sector lenders in EU - is handed EUR 35 bn by German banks, Bundesbank & ECB
7 Sept 08	14 Sept 08	16 Sept 08	22 Sept 08	25 Sept 08	29 Sept 08	
Icelandic Gov takes control of Glitnir (3 rd largest bank). Wachovia, 6 th largest lender in the US, is bought by Citi after FDIC agrees to shoulder losses.	Bradford & Bingley is taken into public ownership. The iTraxx EU Senior Financials reaches its highest ever peak at 229 points	Dexia receives a EUR 6.4 bn cash injection from Belgian, French and Luxembourg Governments	BNP Paribas agrees to take control of Fortis. BNP to become the biggest bank in the EU by deposits. Lifeline to HRE rise to EUR 50bn.	Landsbanki and Kaupthing, 2 nd & 3 rd largest Iceland's Banks, are nationalized. UK Chancellor announces new bank rescue plans	ING accepts EUR 10bn of Gov injection	The bad news on the US economy continue to weigh on broad financial markets. The VIX rose to 81%.
29 Sept 08		30 Sept 08	6 Oct 08	7-8 Oct 08	19 Oct 08	November 08

