EUROPEAN CENTRAL BANK
EUROSYSTEM

WORKING PAPER SERIES

NO 1500 / DECEMBER 2012

NONLINEAR LIQUIDITY ADJUSTMENTS IN THE EURO AREA OVERNIGHT MONEY MARKET

Renaud Beaupain and Alain Durré

In 2012 all ECB publications feature a motif taken from the €50 banknote.

Acknowledgements
The authors thank seminar and conference participants at the University of Cambridge, the Deutsche Bundesbank, the European Central Bank, and SKEMA for insightful comments. The authors are also grateful to e-MID for providing the data and very useful explanations on the functioning of the electronic platform. The opinions expressed in this paper are those of the authors and do not necessarily reflect the views of the European Central Bank or the Eurosystem.

Renaud Beaupain
IÉSEG School of Management and LEM-CNRS (U.M.R. 8179); e-mail: r.beaupain@ieseg.fr

Alain Durré
European Central Bank, IÉSEG School of Management and LEM-CNRS (U.M.R. 8179); e-mail: alain.durre@ecb.europa.eu

Address
Kaiserstrasse 29, 60311 Frankfurt am Main, Germany

Postal address
Postfach 16 03 19, 60066 Frankfurt am Main, Germany

Telephone
+49 69 1344 0

Internet
http://www.ecb.europa.eu

Fax
+49 69 1344 6000

ISSN 1725-2806 (online)

Abstract

The market-oriented approach promoted by the European Central Bank in the design of its refinancing operations creates incentives to credit insitutions to use actively the interbank market to manage their liquidity needs. In this context, we examine the ability of the overnight segment to guarantee the timely provision of unsecured funds to banks to smoothly absorb their liquidity shocks. This paper specifically focuses on the speed of reversion of transaction costs and available depth to their equilibrium levels in this market for overnight unsecured funds from 4 September 2000 to 31 December 2007. The reported evidence points to time-varying liquidity adjustments and identifies liquidity, market activity and the institutional setting of the ECB's refinancing operations as significant determinants of the observed resiliency regimes. Our analysis also shows how the speed of mean reversion of market liquidity, by affecting the level and the volatility of the overnight market rate, also affects the anchoring of the yield curve in the euro area.

Keywords: Overnight money market, market microstructure, transaction costs, price impact, mean reversion, financial turmoil.

JEL classification: C22, C25, G01, G10, G21, E52

Non-technical summary

From the viewpoint of the central bank, it is crucial to ensure a well-functioning money market since this market is the primary source of short-term funds for banks in all countries. As recently illustrated by the current financial crisis that started in August 2007, increased tensions in the money market – reflecting uncertainty of market participants – may rapidly lead to market disruptions, which can in turn endanger the transmission of the monetary policy stance along the yield curve. It is thus essential to observe and to understand the dynamics in the money market in general, and in its overnight segment in particular. It is especially important in the context of the euro area where the ECB through the Eurosystem plays a central role as primary liquidity provider to financial institutions.

In this context, this paper analyses the ability of the overnight segment to ensure the continuation of transactions between banks by providing stable liquidity conditions (and hence, to guarantee the ability to trade) to market participants in both normal and stress periods. Put it differently, this paper addresses the resilience, i.e. the ability of the market to guarantee the timely provision of unsecured funds, of the overnight segment of the euro area money market. It does so using data from 4 September 2000 to 31 December 2007. In this regard, the role of the ECB as liquidity provider in this market is also analysed through its potential impact on the market dynamics coming from the changes into the design of its operational framework (which took place on 10 March 2004) and its increased intervention during the first stage of the financial crisis, i.e. as of August 2007.

Using various indicators borrowed from the literature on microstructure, the following findings are reported. First, it is shown that the introduction of the current design of the operational framework improved the functioning of the market in terms of resilience, even when banks face increasing pressures for balancing their reserves at the end of the reserve maintenance period. Second, we also show how the time-varying speed of reversion of market liquidity to its long-term average, by impacting the level and the volatility of the overnight market rate, also affects the anchoring of the yield curve and the transmission of monetary policy decisions to money market interest rates. With respect to the first stage of the financial crisis, it appears that the increased intermediation role of the ECB has certainly encouraged market participants to continue to trade and provide liquidity in a more costly and volatile environment.

1 Introduction

The crucial role played by the money market as regards the continuation of payment flows (and ultimately lending to the economy) became obvious with the 2007-2012 financial crisis. As the recent experience has demonstrated, financial distress in the money market may lead to a breakdown of interbank transactions while a prolonged illiquidity situation of banks can rapidly damage their solvency. Central banks thus carefully monitor the well-functioning of the money market since this appears of utmost importance to ensure the smooth transmission of monetary policy signals along the yield curve. In this context, this paper analyses the ability of the overnight segment to provide stable liquidity conditions (and hence, to guarantee the ability to trade) to market participants in both normal and stress periods.[1]

In the euro area, monetary policy decisions are implemented according to precise rules[2] which design the so-called operational framework for the monetary policy of the Eurosystem. Following a market-oriented approach, these rules aim notably at creating an active money market between the refinancing operations of the European Central Bank (ECB). The Eurosystem's operational framework therefore creates strong incentives to encourage credit institutions to manage their reserves directly through the interbank market with a view to ending the maintenance period in a balanced position. In this respect, the overnight segment of the euro area money market plays an essential role since it connects cash-poor banks to cash-rich counterparties to meet their short-term liquidity needs between the refinancing operations of the ECB. Against the backdrop of the financial turmoil that started in the summer 2007 over which the volume exchanged in the interbank market decreased markedly, the ability of this market to guarantee the timely provision of unsecured funds under quiet and more stressful conditions therefore takes on particular importance.

The aforementioned considerations explain why central banks stand ready to take the necessary measures to guarantee a well-functioning money market should

[1]Market liquidity traditionally has three dimensions: tightness (transaction costs), depth, and resiliency. The latter captures the temporal dynamics of its first two dimensions (see, e.g., Kyle (1985)).

[2]See ECB (2011).

temporary or permanent market disturbances arise (e.g., in case of financial distress). In the specific case of the ECB, various events support this view over the sample considered in this paper. On the one hand, a new design of the operational framework was introduced in March 2004 to address the persistent volatility of the overnight market rate. On the other hand, the financial turmoil episode has triggered increased interventions by the ECB through a series of one-day fine-tuning operations to provide additional central bank reserves to the banking sector. This paper therefore focuses on two particular issues. First, we examine how the operational framework interacts with the speed of mean reversion of money market liquidity. Second, we explore the role played by the resilience of market liquidity in the transmission of the monetary policy stance to money market rates.

In a number of recent papers, the speed of convergence to stable liquidity conditions has been inferred from the number of quote updates required for transaction costs or market depth to return to their pre-shock levels (Degryse, De Jong, Van Ravenswaaij and Wuyts 2005, Wuyts 2012) or from the probability that liquidity is restored before the occurrence of a new transaction (Foucault, Kadan and Kandel 2005). In the mean reversion framework set up in Kempf, Mayston and Yadav (2009), this temporal dimension of market liquidity can be quantified, which opens the way for new investigations of its dynamics over time or across assets. Examinations of the resilience of order book liquidity nevertheless form the most significant part of the literature, which mostly focuses on the stock market.[3] The speed of mean reversion of liquidity parameters under other market configurations, like in the money market where utilitarian motivations dominate other motivations to trade, nevertheless remains an open question.

Against this background, our contribution to the literature is essentially twofold. First, we check whether the central bank can interfere with market liquidity in a way that makes the money market more (or less) attractive to credit institutions to meet their needs for short-term funds. More specifically, we examine how the design of the operational framework for the implementation of monetary policy decisions affects the speed of reversion of transaction costs and market depth to

[3]For further details, see in particular Gomber, Schweickert and Theissen (2004) or Kempf et al. (2009) on the German Xetra stock market, Degryse et al. (2005) at Paris Bourse, or Large (2007) on SETS at the London Stock Exchange.

their equilibrium levels. In particular, we assess the stability of resiliency over time and look for evidence of nonlinear liquidity adjustments in the overnight segment of this market. We notably report that while resiliency drops markedly as banks face increasing pressures for balancing their reserves in the unsecured overnight market, the introduction of the current design of the operational framework in March 2004 leads to faster mean reversion of spreads and depth. Second, we show how the time-varying speed of mean reversion in market liquidity, by impacting the level and the volatility of the overnight market rate, also affects the anchoring of the yield curve and the transmission of monetary policy decisions to money market rates. To the best of our knowledge, this is the first paper that deals with these specific issues. While recent papers essentially focus on equity markets, we address the issue of the resilience of liquidity in the money market for the first time. Unlike previous research, we draw our conclusions from several years of high-frequency data (i.e., using data from 4 September 2000 to 31 December 2007) and the robustness of our findings is reinforced through a systematic examination of several high- and low-frequency transaction cost and price impact estimators. As we discuss, our results are also robust to alternative model specifications.

The remaining of this paper is organised as follows. We give a brief overview of the design of the euro area money market in Section 2. Section 3 describes the data for interbank transactions and the estimators of market liquidity used in our analysis. The speed of mean reversion of spreads and depth in the overnight money market is examined in Section 4, where we also identify determinants of the time-varying dynamics of liquidity in this market. Section 5 checks the sensitivity of market quality to the speed of mean reversion in spreads and depth. We conclude in Section 6.

2 The Importance of the Central Bank's Refinancing Operations Within the Euro Area Money Market

The money market is the primary source of short-term funds for banks in all countries. In the euro area, a bank's needs for short-term funds is determined by its reserve requirements and the autonomous factors. Credit institutions are indeed obliged to hold minimum reserves (calculated on the basis of the size of their short-term liabilities) at the central bank on average over a specific period of time called the reserve maintenance period (RMP), which is roughly equivalent to one calendar month.[4] Autonomous factors include banknotes in circulation, deposits of governments in the national central banks of the euro area, domestic and foreign assets held by national central banks and other assets. While the reserve requirements are known in advance[5], the evolution of the autonomous factors is more subject to unexpected shocks. Even if financial institutions can extrapolate regular trends in the evolution of most components of these factors (especially banknotes and government deposits) from the past behaviour of their customers, empirical evidence shows that these items remain subject to deviations from regular trends, hence constituting shocks which lead to unexpected (positive or negative) needs for short-term funds. These (unexpected) shocks to autonomous factors may be either idiosyncratic (i.e., affecting the cash position of an individual bank without necessarily impacting the cash position of other banks) or global (i.e., affecting the cash position of all market participants in the money market at the same time; see Durré (2007) for further details). These shocks are particularly significant on specific days where the flow in payment systems is more tense. This phenomenon is usually summarised by the so-called calendar (day) effects (or patterns) during which banks' demand for short-term funds is more pronounced due to the related uncertainty associated with the flows of payments (e.g., at the end of a month, quarter, semester or at the end of a year).

When implementing the decision of the Governing Council on the level of the policy rate (i.e., the minimum bid rate for the refinancing operations of the central bank), the ECB aims to supply the money market with the necessary short-term funds for the banking system to operate smoothly in such a way that very short-term money market interest rates remain appropriately aligned with the monetary

[4]According to the Statute of the European System of Central Banks (ESCB), all credit institutions established in the euro area are subject to the minimum reserve system. These reserves are remunerated over the RMP at the average of the marginal rate on the Eurosystem's MROs. The reserve requirements are determined by the amount of the corresponding institution's liabilities with a maturity up to two years and exceeding EUR 100,000. For further details about the specific features of the Eurosystem's operational framework, see ECB (2011).

[5]Indeed, the balance sheet data of each institution subject to reserve requirements referring to the end of a given calendar month are used to calculate the reserve base for the maintenance period starting in the calendar month two months later (see ECB (2011)).

policy stance signalled by the Governing Council. Injections of short-term funds by the ECB accordingly target neutral cash conditions in the money market over the whole reserve maintenance period. In other words, the injections of cash by the ECB should not constitute additional monetary impulses but should simply reflect the monetary policy stance decided by the Governing Council. In normal times, the ECB's approach to monetary policy implementation relies largely on self-regulating market mechanisms through a rather limited presence in the money market with only few (mostly weekly) operations. The main motivation behind this approach is to ensure the existence of an active money (or interbank) market by maintaining over time sufficient incentives to encourage banks to trade with each other from the shortest to the longest maturity. This notably supports the relative large size of the interest rate corridor in the euro area of 200 basis points (in normal times) formed by the interest rate on the marginal lending facility (i.e., the highest ECB interest rate) and the interest rate on the deposit facility (i.e., the lowest interest rate). When banks need more funds than those provided by the ECB or need funds between the ECB's interventions, the overnight (uncollateralised) segment of the money market is thus the natural place to find short-term funds from cash-rich banks to avoid the recourse to ECB's emergency (marginal or deposit) facilities at a penalty rate (of +/- 100 basis points with respect to the policy rate). From a microstructure perspective, this therefore supports the utilitarian nature of the overnight segment according to which banks essentially trade to meet their liquidity needs (mostly driven by reserve requirements and payment flows) so that the proportion of informed traders is expected to remain low in this market (Furfine 1999, Iori, De Masi, Precup, Gabbi and Caldarelli 2008).

By nature, the central bank's operational framework is thus the initial link between the key ECB interest rates and the market interest rates through which the monetary policy stance is transmitted to other financial instruments and credit institutions. In this regard, narrow spreads between short-term money market rates and the policy rate appear essential to ensure a smooth transmission of monetary policy decisions along the yield curve. In the specific case of the overnight segment in the money market, it is especially important that the spread between the overnight interest rate (including the EONIA and the overnight rate on the e-

MID platform) and the policy rate of the ECB is tight and stable over time. Large and possibly widening spreads would indeed trigger a deterministic deviation of short-term interest rates from monetary policy decisions, which could in turn lead to increasing risk premia along the yield curve, hence undermining the monetary policy transmission mechanisms. In the same vein, excessively volatile spreads would also undermine the clarity of the signal provided by the level of the policy rate and ultimately the credibility of the central bank's operational framework. In short, the volatility of the overnight interest rate caused by its reactiveness to liquidity conditions in the money market should not propagate through the yield curve. This appears a prerequisite for interest rates of term maturities to adequately reflect market expectations of the future path of the policy rate and to have the desired influence on the economic outlook. This is not only a concern for policymakers but also for investors since any uncertainty about the exact information content of market rates would complicate the pricing of most financial instruments.

Since the introduction of the euro in January 1999, the Eurosystem's operational framework appears to have functioned smoothly overall. However, some challenges have emerged on occasions and procedures have been adapted to nullify (or at least to limit) their impact in the money market (see Durré and Nardelli (2008)). In particular, the growing occurrence of underbidding episodes led to significant changes in the operational rules defining the implementation of the monetary policy in the Eurosystem. As explained in Durré and Nardelli (2008), underbidding, by causing imbalanced liquidity conditions, raised the volatility of the overnight market rate. This especially appeared when market participants expected key ECB interest rates to be cut, and hence delayed their accumulation of reserve holdings to meet required reserves in anticipation of more favourable interest rate conditions. As a result, they reduced their participation to weekly ECB's refinancing operations that have occasionally failed to inject the necessary liquidity to ensure a smooth functioning of the banking system, leading to higher overnight interest rates. The following changes were thus introduced on 10 March 2004. First, the timing of the reserve maintenance period was changed so that a maintenance period always starts on the settlement day of the main refinancing operation following the Governing Council meeting at which the monthly assessment of the monetary policy stance is pre-scheduled. Second, changes to the standing facility rates are implemented at the start of the new reserve maintenance period. Finally, the maturity of the main refinancing operations was shortened from two weeks to one week. As reported in Durré and Nardelli (2008) or Beaupain and Durré (2008), these structural changes have significantly altered the dynamics of the overnight segment. In particular, these changes have led to a situation in which expectations of key ECB interest rates are flat over the entire maintenance period, and there are thus no more incentives for underbidding. For a detailed description of the operational framework and its link to the segments of the money market, see ECB (2003), ECB (2008), or Beaupain and Durré (2008).

Further research reports how the operational frameworks of central banks drive the dynamics of interbank money markets (see, e.g., Hamilton (1996) or Pérez Quirós and Rodríguez Mendizábal (2006)). More specifically, the literature documents how the rules defining the implementation of the monetary policy decisions contained in the frameworks make the overnight market rate particularly sensitive to the level of stress faced by market participants. In this respect, more binding reserve requirements towards the end of the maintenance period notably raise the volatility of the market for short-term funds (see, e.g., Spindt and Hoffmeister (1988), Eagle (1995), Griffiths and Winters (1995), Bartolini, Bertola and Prati (2001), and Bartolini, Bertola and Prati (2002) for the fed funds, or Hartmann, Manna and Manzanares (2001), Benito, León and Nave (2007), Gaspar, Pérez Quirós and Rodríguez Mendizábal (2008), Cassola, Durré and Holthausen (2011), and Cassola, Hortacsu and Kastl (2011) for the money market in the euro area). Similar forces drive the intraday operation of those markets. Market activity clusters at both ends of the trading session (Angelini 2000, Cyree and Winters 2001, Hartmann et al. 2001, Bartolini, Gudell, Hilton and Schwarz 2005). Volatility peaks near the close of trading when market participants face high pressure for finding the necessary short-term funds to end the day in a balanced position (Spindt and Hoffmeister 1988, Griffiths and Winters 1995).

As shown by these studies, and even more recently by the financial crisis that started in August 2007, the central bank is thus in a position to influence the dynamics of the money market (in both the activity and prices terms) by either increasing or decreasing its intermediation role. Whether the central bank can interfere with the dynamics of overnight market liquidity in a way that enhances the speed of convergence of transaction costs and market depth to their equilibrium levels is an open question that takes on particular importance in the European context.

3 Data: Definition and Treatment

In the euro area, interbank transactions are alternatively executed electronically or over-the-counter (mainly in the form of bilateral deals or through voice brokers). Empirical evidence reported in previous research shows that the order flow captured by the e-MID electronic platform is representative of the dynamics of the whole money market (Beaupain and Durré 2011), which alleviates our concerns about sample selection bias. The relative order flow captured by the electronic platform further remained stable (with respect to the trades executed over-the-counter) until the collapse of Lehman Brothers. Data for the orders filled on the platform is accordingly provided by e-MID and contains records of all overnight transactions executed through their systems.[6] When a trade occurs, a new record is created that reports the date, time, price, size and side of the deal (i.e., buy or sell). Our sample covers the period from 4 September 2000 to 31 December 2007. Erroneous records and extreme outliers are removed from the raw tick-by-tick data provided by the platform.[7] In spite of more stable market conditions in the euro area between January and August 2008, the period beyond December 2007 was not incorporated in our sample for the following reasons. First, credit institutions may have been more reluctant to disclose any liquidity shortage in a transparent way (through the platform) while central banks around the world were injecting massively liquidity in the market. Second, as a related matter, banks' solvency has also become more uncertain. In reaction, while small- and

[6] See Beaupain and Durré (2011) for a detailed description of the functioning of the electronic platform.

[7] The records for which a date, time, price or quantity is missing or negative are removed. Deals with a price recorded outside the corridor defined by the ECB's marginal lending and deposit rates are filtered out. Finally, trades executed before 08:30:00 or after 18:00:00 are not included in the filtered data set.

medium-sized banks remained active on the electronic platform, anecdotal evidence suggests that some big market participants tended to move to the more opaque over-the-counter channel for the provision of unsecured liquidity, where they only disclosed their liquidity needs to selected counterparties. Third, growing concern about potential price pressures in the medium term has motivated a 25 bps increase of the key ECB interest rates on 3 July 2008. Finally, the introduction of a fixed-rate full-allotment procedure by the ECB to offset market distortions following the collapse of Lehman Brothers on 15 September 2008 has radically affected the operation of this market.

In this paper, we examine the temporal dynamics of the first two dimensions of market liquidity identified in the theoretical literature (Kyle 1985), that is, tightness and depth. For this purpose, the cost of trading in this market is inferred from high-frequency and low-frequency spread estimators. Price impact, that is, the reaction of prices to the volume of transactions executed in the market, is similarly used to approximate market depth. Although, due to the utilitarian nature of the transactions executed in this market, informed trading is expected to remain relatively low, we cannot however reject that on some occasions market participants trade for informed reasons. We therefore systematically check the robustness of our findings across different alternative measures of market liquidity which are known for incorporating asymmetric information in different ways (see Goyenko, Holden and Trzcinka (2009) or Hasbrouck (2009) for an assessment of their relative performance). The absence of significant differences between liquidity measures would accordingly suggest that informed trading does not bias our results. All our estimators are computed at the daily frequency. Where applicable and unless otherwise mentioned, we use Goyenko et al.'s (2009) definitions.

3.1 Transaction Costs

Roll's (1984) implicit effective spread. Roll (1984) introduces a method for inferring the effective spread from the first order serial covariance of price changes. In the spirit of Stoll (2000), this implicit spread is extracted from price changes observed over consecutive transactions (Δp_t) and Roll's (1984) estimator is accordingly computed as:

$$ROLL = \begin{cases} 2 \times \sqrt{-Cov_d(\Delta p_t, \Delta p_{t-1})} & \text{if} \quad Cov_d(\Delta p_t, \Delta p_{t-1}) < 0 \\ 0 & \text{otherwise} \end{cases}$$

where Cov is the first order serial covariance.

Stoll's (2000) traded spread. The traded spread is measured as the difference between the average price of buy transactions (i.e., trades hitting the ask) and the average price of sell trades (i.e., executed on the bid side of the market) (Stoll 2000). We accordingly compute the traded spread from the transactions executed on the electronic platform. The equally-weighted average traded spread (EWTS) gives an equal weight to all transactions and is computed as:

$$EWTS = \frac{1}{B} \times \sum_{b=1}^{B} p_b - \frac{1}{S} \times \sum_{s=1}^{S} p_s$$

where p_b (resp. p_s) is the price of the b^{th} buy trade (resp. s^{th} sell trade) executed in the market.

We alternatively construct a time-weighted average traded spread (TWTS) in which the weight of each observation is a function of the number of seconds before a new transaction occurs on the same side of the market (i.e., a function of the time the related quote remains unchanged in the market), that is,

$$TWTS = \frac{\sum_{b=1}^{B} \omega_b p_b}{\sum_{b=1}^{B} \omega_b} - \frac{\sum_{s=1}^{S} \omega_s p_s}{\sum_{s=1}^{S} \omega_s}$$

where ω_b (resp. ω_s) is the number of seconds between trade b and $b+1$ (resp. s and $s+1$).

Huang and Stoll's (1996) realised spread. The realised spread captures the temporary component of the effective spread and is here measured as:

$$EWRS = \frac{1}{T}\sum_{t=1}^{T} 2 \times D_t \times (p_t - p_{t+5})$$

where D_t is 1 (resp. -1) if the t^{th} transaction is a buy (resp. sell), p_t is the price of trade t and p_{t+5} is the price of a transaction executed 5 minutes after trade t.

3.2 Price Impact

Amihud's (2002) illiquidity ratio. Amihud (2002) shows that the illiquidity of a market is a function of the absolute change in the price in reaction to a given volume of transaction. The illiquidity ratio of day d is accordingly computed as:

$$AMIHUD_d = \frac{|\Delta p_d|}{Q_d}$$

where Q_d is the total volume exchanged on day d.

Kyle's (1985) lambda. While Amihud's (2002) illiquidity ratio captures the reaction of prices to exchanged volumes on a daily basis, it fails to capture the intraday reaction of the price to the size of the transactions. This however takes on particular importance when banks split their orders in smaller parts to avoid the market inferring information on their specific liquidity needs. This appears even more relevant against the confidence crisis experienced over the recent turmoil episode, during which market participants became extremely reluctant to disclose their full positions on transparent systems to avoid the market misinterpreting their financial needs. To gain further insight into this dimension, we estimate Kyle's (1985) lambda from 5-minute price changes (Δp_t) and trade imbalances ($IMBAL_t$):

$$\begin{aligned} \Delta p_t &= \lambda IMBAL_t + \varepsilon_t \\ \text{where} \quad IMBAL_t &= \textstyle\sum_{t=1}^{T} D_t \sqrt{Q_t} \end{aligned}$$

where the daily λ estimate is a measure of the 5-minute impact of trades on prices for day d (hereafter $KYLEL_d$).

Descriptive statistics for our liquidity proxies are reported in Panel A of Table

Table 9: Execution Quality, Resiliency Regimes, and the Operational Changes

Panel A – Electronic Trades vs. the EONIA across Resiliency Regimes

	Spread Proxies				Depth Proxies	
Regime	ROLL	EWTS	TWTS	EWRS	AMIHUD	KYLEL
Mean						
High Resilience	0.0019	0.0020	0.0019	0.0021	0.0022	0.0022
Low Resilience	0.0074	0.0078	0.0073	0.0084	0.0086	0.0089
Welch F-test	182.3540***	160.8156***	166.3462***	146.6322***	145.2618***	145.1443***
Standard Deviation						
High Resilience	0.0015	0.0018	0.0018	0.0023	0.0028	0.0026
Low Resilience	0.0093	0.0097	0.0093	0.0100	0.0100	0.0102
Brown-Forsythe	397.4756***	391.4293***	356.8770***	411.5148***	394.8372***	403.1872***
Median						
High Resilience	0.0016	0.0017	0.0016	0.0017	0.0017	0.0017
Low Resilience	0.0040	0.0041	0.0039	0.0046	0.0048	0.0053
van der Waerden	310.0958***	302.5492***	291.5412***	284.8930***	296.3069***	319.7861***

Panel B – Electronic Trades vs. the EONIA, Resiliency Regimes, and the Operational Changes

	Spread Proxies				Depth Proxies	
Regime	ROLL	EWTS	TWTS	EWRS	AMIHUD	KYLEL
Constant	0.0051***	0.0056***	0.0050***	0.0059***	0.0083***	0.0076***
	(7.6799)	(6.8606)	(7.0392)	(7.0846)	(6.8549)	(7.2897)
OF	0.0032***	0.0029***	0.0028***	0.0037***	−0.0010	0.0011
	(3.4384)	(2.6985)	(2.9859)	(3.1314)	(-0.7175)	(0.8599)
Turmoil	0.0006	0.0001	0.0007	0.0003	−0.0004	−0.0009
	(0.5342)	(0.1192)	(0.5582)	(0.2503)	(-0.2390)	(-0.5829)
High Resilience	−0.0039***	−0.0043***	−0.0038***	−0.0045***	−0.0070***	−0.0062***
	(-5.9574)	(-5.2803)	(-5.3425)	(-5.4968)	(-5.7474)	(-6.0283)
OF × High Resilience	−0.0026***	−0.0023**	−0.0023**	−0.0029**	0.0017	−0.0003
	(-2.7555)	(-2.1122)	(-2.3527)	(-2.4230)	(1.2209)	(-0.2523)
Turmoil × High Resilience	0.0007	0.0007	0.0004	0.0020	0.0007	0.0028*
	(0.5416)	(0.4862)	(0.3381)	(1.1491)	(0.4497)	(1.8331)
Spread_{t-1}	0.1490***	0.1522***	0.1641***	0.1144***	0.1678***	0.1448***
	(4.5825)	(4.6378)	(5.1308)	(3.1482)	(5.0873)	(4.7903)
Adjusted R^2	0.2411	0.2384	0.2267	0.2431	0.2337	0.2433

This Table reports the absolute proportional spread between the price of electronic trades and the EONIA across resiliency regimes and following changes to the operational framework for the implementation of the monetary policy. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. t-statistics are reported in the parentheses and are based on Newey and West's (1987) robust standard errors.