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**Working Paper**

## Monetary policy in exceptional times

ECB Working Paper, No. 1253

**Provided in Cooperation with:**

European Central Bank (ECB)

*Suggested Citation:* Lenza, Michele; Pill, Huw; Reichlin, Lucrezia (2010) : Monetary policy in exceptional times, ECB Working Paper, No. 1253, European Central Bank (ECB), Frankfurt a. M.

This Version is available at:

<https://hdl.handle.net/10419/153687>

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EUROPEAN CENTRAL BANK

EUROSYSTEM

## WORKING PAPER SERIES

NO 1253 / OCTOBER 2010

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by Michele Lenza,  
Huw Pill and  
Lucrezia Reichlin



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# MONETARY POLICY IN EXCEPTIONAL TIMES<sup>1</sup>

by Michele Lenza<sup>2</sup>, Huw Pill<sup>2</sup>  
and Lucrezia Reichlin<sup>3</sup>



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<sup>1</sup> We are grateful to our discussant, Morten Ravn, Domenico Giannone, Oreste Tristani, Francesco Drudi, Paola Donati, Alain Durré, Phil Davis, our anonymous referees, participants at the Economic Policy Panel and seminars at the Bank of England and ECB for helpful comments.

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ISSN 1725-2806 (online)



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**Abstract:** This paper describes the response of three central banks to the 2007-09 financial crisis: the European Central Bank, the Federal Reserve and the Bank of England. In particular, the paper discusses the design, implementation and impact of so-called “non-standard” monetary policy measures focusing on those introduced in the euro area in the aftermath of the failure of Lehman Brothers in September 2008. Having established the impact of these measures on various observable money market spreads, we propose an empirical exercise intended to quantify the macroeconomic impact of non-standard monetary policy measures insofar as it has been transmitted via these spreads. The results suggest that non-standard measures have played a quantitatively significant role in stabilising the financial sector and economy after the collapse of Lehman Bros., even if insufficient to avoid a significant fall in economic and financial activity.

**JEL classification:** E52 (monetary policy); E58 (central banks and their policies).

**Key words:** Non-standard monetary policy, financial crisis.

## NON-TECHNICAL SUMMARY

Following the failure of Lehman Brothers in September 2008, tensions in financial markets – and particularly in the money markets – intensified substantially. Interest rate spreads in the euro, dollar and sterling money markets rose to unprecedented levels, market activity ‘seized up’ as transaction volumes declined precipitously (especially at term maturities) and the effectiveness of monetary policy transmission appeared threatened.

All this required an immediate and decisive policy response. In addition to easing monetary policy through conventional means (i.e. lowering short-term interest rates), central banks introduced a set of so-called non-standard policy measures to address the implied challenges. The design of these measures varied from one jurisdiction to another. Yet, despite differences in form, they all aimed at similar goals: to support market functioning and prevent a severe disruption of the financial system, which would have threatened macroeconomic activity and price stability over the medium term.

Those differences in the design of non-standard measures that did emerge in their implementation across countries during late 2008 and early 2009 largely reflected differences in: (a) the design of the pre-crisis operational framework for the implementation of monetary policy (such as the volume of outstanding monetary policy operations, the overall size of the central bank balance sheet; the remuneration of reserve requirements, etc.); and (b) the structure of the financial sector in the relevant region.

For example, the flexible and rich set of instruments available to the ECB, as a consequence of its modern and efficient operational framework, facilitated the Eurosystem’s response to the ‘seizing up’ of the money markets. In particular, its design proved to be well-suited to facilitate greater central bank intermediation of transactions that, in normal times, would have been settled directly between banks in the interbank money market. Moreover, the Eurosystem’s programme of “enhanced credit support” differed from the responses of the Federal Reserve and Bank of England in part as a reflection of the predominantly bank-centred structure of corporate and household financing in the euro area.

On the basis of a detailed description and analysis of the non-standard measures introduced by the Eurosystem after September 2008, it is possible to identify and quantify the impact of these measures on a number of specific euro money market interest rate spreads. In particular, the measures: (a) by facilitating central bank intermediation and thus the by-passing of the malfunctioning interbank market, over time succeeded in narrowing substantially the spread between the unsecured interbank deposit rate (e.g. 3-month EURIBOR, which forms the basis for many bank loan contracts with firms and households) and the overnight interest swap (OIS) rate (which offers a proxy for secured rates); (b) resulted in a widening of the spread of the overnight money market rate (EONIA) below the conventional policy rate (the rate at the Eurosystem’s main refinancing operations (MROs)); and (c) helped to flatten the money market yield curve (as proxied by the spread between the 12-month EURIBOR and the 3-month EURIBOR). Taken together, these three dimensions of the impact of non-standard measures on money market spreads are of sufficient size to exert a macroeconomic impact.

In quantifying the macroeconomic impact of the non-standard measures on the basis of the evolution of these spreads, three important caveats need to be kept in mind. First, any such exercise is fraught with identification problems. It is simply very difficult in macroeconomic data to distinguish the impact of the macroeconomic and

financial shocks that triggered the financial crisis from the impact of the central bank responses to those shocks, not least because temporally these two factors occurred almost instantaneously, as a result of the prompt and decisive action necessarily taken by the authorities in September and October 2008. Second, by construction the exercise explores only one channel of transmission, namely via interest rate spreads. Effects operating through confidence or other channels are neglected and may (substantially) augment the impact of the non-standard measures on the real economy and financial system. Third, a model is required to translate the spread effects into quantified macroeconomic impacts. But the stability of the model in the face of the financial crisis may be open to question, given the novel nature and magnitude of the shocks experienced.

Using the Bayesian vector autoregression framework developed by Giannone et al. (2009), the impact of non-standard monetary policy measures on macroeconomic variables via interest rate spreads is found to have played a quantitatively significant role in stabilising the euro area financial sector and economy after the collapse of Lehman Brothers, even if it was insufficient to avoid a significant fall in economic and financial activity.

More specifically, the results of counterfactual exercises undertaken using the B-VAR model suggest that non-standard measures had a positive influence on economic activity (resulting in an unemployment rate about 0.5 percentage points lower than would have been the case following Lehman's collapse in the absence of such measures, on the basis of the median estimate). Moreover, the non-standard measures also supported the flow of bank loans to the household and corporate sectors. In the former case, the positive impact is around 1.5 percentage points on the annual growth rate of loans after two years. In the latter case, the peak positive effect is greater – at around 3 percentage points on the annual growth rate – but comes with a longer lag (and the transmission is non-monotonic).

It remains premature to come to a definitive conclusion on the overall macroeconomic effectiveness of non-standard monetary policy measures. However, the results of the exploratory counterfactual exercises presented in this paper suggest that, at this preliminary stage, the overall impact has been positive and of appreciable magnitude. Yet, at the same time, such measures do not offer a panacea. Caution is warranted in believing that such measures can offset fully macroeconomic shocks of the magnitude seen in late 2008 or that augmentation of such measures would lead to macroeconomic effects of similar magnitude in the future.



## 1. INTRODUCTION

Exceptional times call for exceptional measures. In the face of the financial crisis of 2007-08, policy makers responded in significant and innovative ways. Central banks have been in the forefront of this response. Both standard and non-standard monetary policy measures have been implemented in an attempt to contain the financial turmoil and stabilise the economy. Although uncertainty persists regarding the extent to which the health of the financial system has been restored, there is no doubt that a meltdown akin to that seen at the outset of the Great Depression – which appeared possible in the autumn of 2008 – has been avoided. To a great extent, confidence has been restored.

This paper describes the way in which three major central banks – the European Central Bank (ECB), the Federal Reserve and the Bank of England – achieved this remarkable result. In particular, we focus on the non-standard monetary policy measures introduced since August 2007.

Our description of central bank actions distinguishes between two periods: before and after the failure of Lehman Bros. in September 2008. In the pre-Lehman period, all three central banks provided support to financial markets through changing the composition of their balance sheets in various ways, while leaving the overall size of their balance sheets unchanged. By contrast, after the collapse of Lehman, all three central banks expanded their balance sheets and, as a consequence, the monetary base.

We argue that, although the response of the three institutions differed both in the specifics of the policies adopted and with regard to the accompanying rhetoric, many common features can be identified. Differences across the central banks should be understood, at least in part, in light of the varying design of their operational frameworks for monetary policy implementation and the different structure of financial systems in the three jurisdictions. For example, the Eurosystem has always had a larger balance sheet than either the Federal Reserve or the Bank of England. Therefore the ECB did not need the same proportional increase in its balance sheet to the same extent as the other two institutions to accommodate the heightened demand for central bank liquidity that emerged during the financial crisis. Moreover, given the importance of banks (rather than markets or other financial intermediaries) as sources of external funds in the euro area, it is understandable that the ECB opted to deal primarily through the banking system – that is, with its regular operational counterparts – rather than extending its facilities to a wider range of counterparties in the manner of the Federal Reserve. On this reading, the distinguishing features of the ECB’s “enhanced credit support” therefore reflect the distinctive character of the euro area economy, rather than a more fundamental difference in policy objectives or conduct.

As already noted, a common feature of the non-standard monetary policies in the period following the Lehman collapse is an expansion of the monetary base, *i.e.* so-called “quantitative easing.” The nature and magnitude of the macroeconomic impact of such quantitative easing are the subject of intense debate. The Japanese experience at the turn of the millennium has been the object of heated controversy (*e.g.* Ahearne, et al., 2002).

In this paper, we argue that both quantitative easing and the other non-standard measures introduced by central banks that changed the composition of the asset side of their balance sheets (so-called “qualitative easing”) acted largely through their effects on interest rates and, in particular, on money market spreads, rather than solely or mainly through “quantity effects” in terms of the money supply. In this sense, the effect of these non-standard policies can be quantified by studying how the reduction of these spreads is transmitted to the broader economy. Compared with previous studies that have analysed the transmission of monetary policy in normal times, the analysis of non-standard policies presented here is concerned with the impact of a reduction of interest rate spreads given the level of the key policy rate, rather than changes in the key policy rate itself.

This approach is used to quantify the effect of non-standard policies in the euro area after the collapse of Lehman. The empirical analysis is based on an econometric tool developed by Giannone, et al. (2009) to study the transmission of monetary policy to prices, the real economy and a set of disaggregated monetary and credit variables. The model is a Bayesian vector autoregression (B-VAR) including thirty-two monthly variables. In this paper, we use the B-VAR model to perform counterfactual exercises, based on assumptions regarding how interest rate spreads would have evolved with and without the introduction of non-standard measures.

The remainder of the paper is organised as follows. Section 2 offers a brief characterisation of non-standard monetary policy measures. Section 3 analyses the design and implementation of such measures by the ECB, Federal Reserve and Bank of England. Sections 4 and 5 develop the empirical exercise. Section 6 briefly concludes.

## 2. CHARACTERIZING NON-STANDARD MEASURES

In the face of the financial market turmoil that emerged globally in August 2007 and intensified in September 2008, central banks responded with both standard and non-standard monetary policy measures.

Characterizing the former is relatively straightforward: key central bank interest rates were cut substantially, reflecting a conventional monetary policy reaction to a slowing economy. A very large literature has analysed the impact of such actions on real activity and the price level. However, characterizing and evaluating the latter is more challenging. By their nature, non-standard measures lie outside the regular conduct of monetary policy and, as such, the literature addressing them – especially on the empirical side – is inevitably somewhat sparse.

As a starting point in attempting to fill this lacuna, we first attempt to characterize non-standard central bank measures. Many of the non-standard measures introduced in 2007-08 involved modifications to the procedures

and tools used to implement monetary policy. Such modifications have implied major changes in the role played by central banks: as intermediaries in the interbank money market; as holders and managers of securities portfolios; and as “lenders of last resort”. Moreover, these innovations in operating procedures have had implications for the signalling and transmission of the stance of monetary policy to financial markets and the real economy.

In developing a typology of non-standard measures, we distinguish along three dimensions: (a) the immediate impact of the measures on the central bank balance sheet, which reflects the specific transactions undertaken by the central bank in implementing the measures; (b) the choice of counterparties for the non-standard central bank transactions, which has implications for whether non-standard measures aim at replacing or re-activating private financial market activity; and (c) the intent of the measures, specifically whether they, on the one hand, reflect an attempt to re-establish or enhance conventional channels of monetary transmission or, on the other hand, are intended to exploit typically neglected channels of transmission, as the scope to lower interest rates becomes constrained by the approach of a lower bound.

## **2.1. Impact on central bank balance sheet: Expanding or changing composition?**

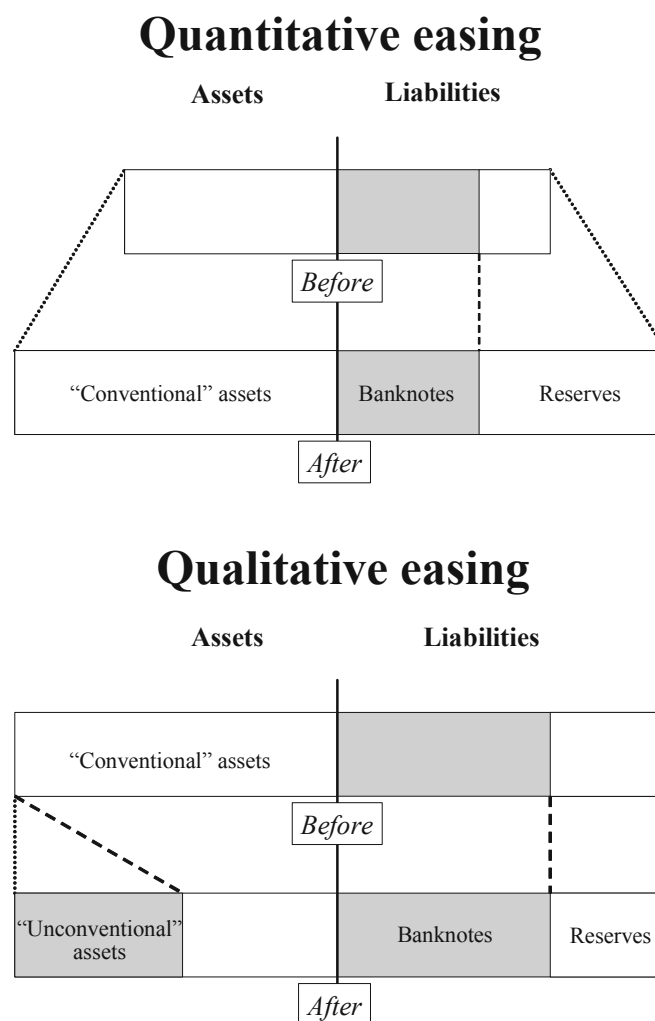
A “textbook view” of central bank balance sheet management (e.g. Goodfriend, 2009; Shiratsuka, 2009) distinguishes between “quantitative easing” and “qualitative easing” (or “credit policy” / “credit easing”) on the following grounds.

Quantitative easing entails an expansion of the central bank balance sheet – and, in particular, an expansion of the monetary base. At the same time, quantitative easing does not alter the composition of the asset side of the balance sheet. In other words, central bank holdings of “conventional assets” (i.e. assets held by the central bank in “normal times”) are simply increased. By implication, the portfolio of assets held by the central bank is not changed: the share of each asset category in total holdings does not alter substantially and no new asset classes are added to the portfolio.<sup>1</sup> On the liability side, given that banknotes are provided perfectly elastically and are thus demand determined, the increase in the monetary base is reflected in an accumulation of central bank reserves (see Figure 1).

The converse is true for pure qualitative easing. In that case, the overall size of the central bank balance sheet is left untouched, but the composition of asset holdings is changed such that “unconventional assets” are introduced at the expense of conventional assets.

1 Of course, in assessing whether this criterion is met, one has to come to a view regarding which asset characteristics are most relevant: the issuer, the credit quality (or rating), the maturity, etc.

Figure 1: Quantitative versus qualitative easing – Textbook view



In practice, the non-standard measures implemented by central banks after 2007 cannot be easily mapped into this textbook distinction. For example, the ECB’s “enhanced credit support” (Trichet, 2009) represented a distinctive approach focused on underpinning bank funding and money market functioning (Stark, 2009). This resulted in changes in both the size and the composition of the Eurosystem’s balance sheet as described and discussed in Section 3. As such, the labels “quantitative easing” or “qualitative easing” cannot be straightforwardly applied: rather a richer, more nuanced description is required.

## 2.2. Choice of counterparties: Replacing or re-activating the market?

Policy measures may be non-standard not only because of the nature of the transactions conducted, but also because of the counterparties chosen for those transactions. Traditionally, central banks dealt solely with banks, on the basis that these are regulated institutions central to the payments system and credit creation. In response

to the crisis, central banks had to choose whether to continue to deal only with these regular counterparties or to open their operations to others.

Choosing whether to enlarge the set of counterparties reflects a key conceptual choice in the design of non-standard measures. In particular, it governs whether they aim: at replacing / by-passing a market that is impaired or, alternatively, at re-activating private activity in that market.

As we will see in the next section, many of the interventions undertaken by central banks from August 2007 onwards offered scope for greater central bank intermediation of bank-to-bank transactions, at a time when the interbank money market had seized up (Papademos, 2009). This is an example of replacing private market activity. Given the centrality of the money market to the transmission of monetary policy, it has been recognized at least since Bagehot that central banks have little alternative but to offer these intermediation services at times when “panic” precludes interbank transactions. In providing such intermediation, however, central banks recognize that they are potentially crowding out market activity, creating various forms of dependency on central bank measures and thus complicating eventual normalization and exit from such measures.

Looking beyond the money market, the scope for variation in central bank responses widens. For example, to the extent that non-standard measures are designed to support the credit creation process (and thus real activity, which depends upon it), one can envisage central banks: (a) working through the banking system (and thus supporting loan supply), an example of attempts to revive private activity; (b) supporting the functioning of private credit markets (e.g. by acting as a *de facto* market maker), which allows scope for the non-financial sector to by-pass an impaired banking system by substituting into capital market-based forms of external finance; or (c) providing credit directly to the non-financial sector, which can be seen as an attempt to replace the malfunctioning financial sector.

### **2.3. Complementing or substituting for interest rate cuts?**

Another conceptual distinction in the design of non-standard measures is the extent to which they are intended to complement or substitute for conventional monetary policy actions. In principle, we can distinguish two cases.

First, non-standard measures may be designed to improve the effectiveness of conventional monetary policy actions. In such circumstances, the non-standard measures should be seen as complements to interest rate cuts. Many of the measures taken after the emergence of money market tensions in August 2007 – notably the support to the functioning of the money market – can be seen in this light. Indeed, the impact of these measures is often summarized by analyzing their impact on the money market spreads. (We also follow this approach in our empirical exercise below.) The containment and stabilization of these spreads ensured that monetary policy decisions steering the overnight rate were transmitted to longer-maturity market rates of more relevance to the financing and spending decisions of firms and households.

Other non-standard measures may be intended to ease financing conditions further once the scope for conventional easing has run out, e.g. when the scope to lower nominal short-term interest rates further is constrained by a lower bound. By their nature, such measures are, at least potentially, substitutes for conventional monetary policy.



As will become apparent in the narrative presented in Section 3, in practice it is not easy to classify non-standard measures along this dimension. By implication, the clarity with which central banks have been able to communicate the monetary policy stance – which in the current environment can no longer be captured solely by the level of a very short-term interest rate (such as the EONIA in the euro area) – has been impaired. Moreover, empirical exercises evaluating the effectiveness of non-standard measures face substantial identification problems in attempting to distinguish their impact from that of contemporaneous conventional policy actions. This is a challenge we face in Section 5.

### **3. NON-STANDARD MEASURES AT THREE CENTRAL BANKS**

In describing the conduct of monetary policy and the introduction of non-standard measures during the financial crisis, it is useful to distinguish between two periods: before and after the failure of Lehman Bros. in September 2008.

Up to Lehman's demise, non-standard measures represented variations on “qualitative easing” (as defined in the previous section), with the composition – rather than the size – of the central bank balance sheet changing. By contrast, after the failure of Lehman, central bank balance sheets expanded strongly (even as the composition of the asset side continued to evolve), implying a combination of both quantitative and qualitative easing. The remainder of this section describes the evolution of non-standard central bank policy measures over these two periods. It identifies a number of similarities and differences in the implementation of non-standard measures across the three central banks surveyed.

#### **3.1. Turmoil: August 2007 – mid-September 2008**

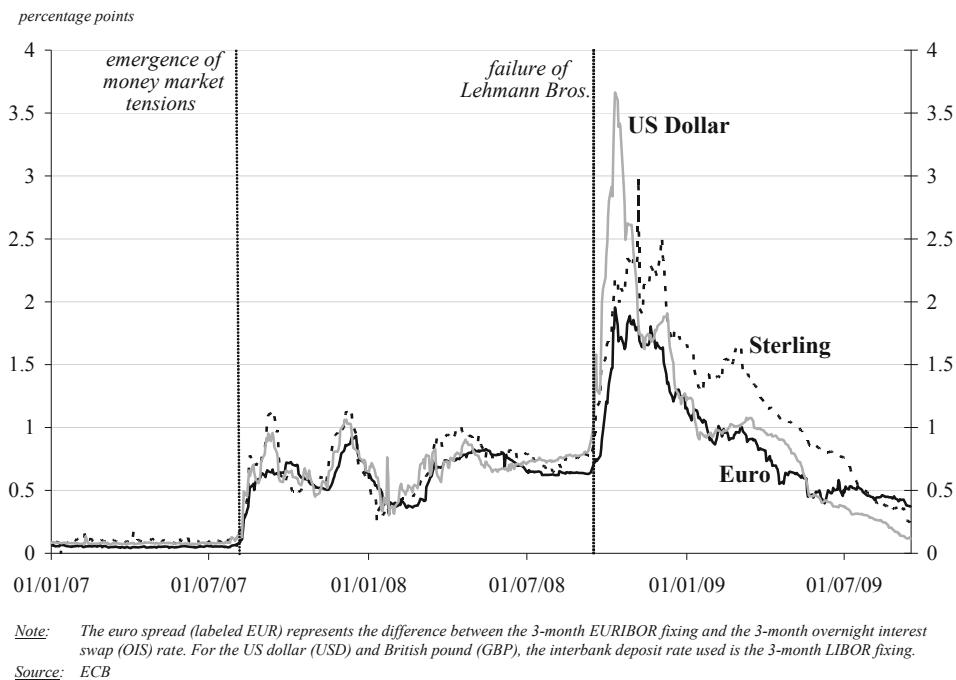
Following a prolonged period of strong loan growth, rising asset prices and narrowing credit spreads, financial turmoil first became apparent in mid-2007. Initially confined to markets for asset-backed securities in the United States, by early 2008 market tension had become widespread. In particular, in August 2007 significant tensions emerged in the money markets. In the US, UK and euro area, spreads between secured and unsecured money markets rates rose to unprecedented levels (see Figure 2), while interbank transactions volumes fell to low levels at longer maturities.

The causes of these tensions have been widely discussed elsewhere.<sup>2</sup> We do not repeat them here. Rather, we simply stress that central banks were confronted with a seizing-up of the inter-bank money market (especially at longer maturities) and the emergence of very large spreads between, on the one hand, unsecured interbank deposit rates and, on the other, secured and swap rates. Uncertain of the availability of short-term financing in the money market, banks' demand for central bank liquidity rose significantly.

2 e.g. Gorton (2008).



**Figure 2: Spread between interbank deposits and OIS rates at 3-month maturity**



Central banks responded to these developments by refining their liquidity management techniques (i.e. their choice of the instruments and procedures to be employed in the context of monetary policy operations). While superficially the actions taken during the period between August 2007 and September 2008 appear quite diverse (as reflected in the more detailed description of the measures taken by individual central banks presented below), in practice a number of common themes exist.

In particular, during this pre-Lehman period all central banks kept their liquidity management measures distinct from those taken regarding the monetary policy stance,<sup>3</sup> in two specific senses. First, innovations in liquidity management were not intended to lead to a deviation of very short-term interest rates (notably the overnight money market rate) from the key policy rate. Second, the liquidity operations undertaken did not increase the outstanding stock of monetary liabilities on the central banks' balance sheets.<sup>4</sup> Given these elements, it remained possible to continue to characterize the monetary policy stance largely in terms of the level of very short-term interest rates (as in normal times). Of course, policy decisions regarding the stance had to take into account money market conditions and their impact on the level and volatility of money market rates (which represent important links in the chain of monetary policy transmission). But such decisions could be taken distinctly from those regarding liquidity management.

3 At the ECB, this distinction was elevated to the status of a “*separation principle*” (see Stark, 2008). Maintaining the distinction between monetary policy and liquidity operations was particularly important in the ECB's case, since the need to address upside risks to inflation (possible second round effects stemming from the very high level of oil prices then observed) required a tightening of the monetary policy stance, even though liquidity operations were characterized as supportive.

4 A small exception emerges here with regard to the Bank of England since – due to specific technical details of its operational framework (viz. the voluntary and flexible level of reserves required in the maintenance period and the “reserve band” at the end of the maintenance period) – it was possible for the reserves to expand somewhat without a significant impact on the level of overnight market rates.

If liquidity operations were not intended to change the monetary policy stance, then what was their role? In large part, innovations in the operational procedures of the central banks between August 2007 and September 2008 were designed to achieve two inter-related objectives: first, to support interbank intermediation in the money market; and second, to introduce the necessary liquidity into bank balance sheets, which were becoming “blocked” by the accumulation of illiquid assets, notably asset-backed securities. Across the three jurisdictions, these objectives required that the central bank could offer a sufficiently large volume of liquidity to a sufficiently large number of counterparties so that transactions – which, in normal times, had been settled between banks directly in the money market – could now be settled across the central bank balance sheet. And they had to offer a facility that allowed banks which had to refinance illiquid assets to do so, thereby avoiding a “fire sale” of these illiquid assets that would further erode bank capital and destabilise markets.

Despite the common objectives of the non-standard measures, the details of central bank responses with respect to liquidity management appear to vary substantially.

The ECB was in the vanguard of acting to address the initial emergence of money market tensions. It conducted a number of large fine tuning operations in early August to contain the rise in money market spreads. These operations accommodated heightened demand for liquidity at a time of great uncertainty. Subsequently, the ECB changed the timing of liquidity provision within the reserve maintenance period (thereby accommodating banks’ demand for so-called “frontloading” of reserve accumulation<sup>5</sup>) and lengthened the maturity of its outstanding operations<sup>6</sup> while leaving the total volume of outstanding operations unchanged.

The Bank of England was initially more hesitant in employing liquidity operations, but – following the run on Northern Rock in mid-September 2007 – it subsequently also adopted a more active approach to liquidity management. Like the ECB (albeit from a different starting point), the Bank of England increased the average maturity of its outstanding operations. It also widened the range of collateral eligible for its longer-term repo operations to include (highly rated) asset-backed securities (ABS), thereby mimicking the very broad definition of eligible collateral adopted by the ECB from the outset. In April 2008, the Bank of England introduced a new facility – the so-called Special Liquidity Scheme – that allowed banks to swap some of the illiquid assets on their balance sheets (notably ABS) for liquid Treasury bills for a period of up to three years.

With the exception of this asset swap scheme, most of the measures adopted by the ECB and Bank of England involved the use of instruments or procedures that were foreseen in these central banks’ existing operational framework. By contrast, the Federal Reserve – in addition to providing additional liquidity through its regular operations and lengthening the maturity of loans granted at the discount window – introduced a set of new facilities. First and most importantly, in December 2007 the Federal Reserve created the term auction facility (TAF) to provide liquidity to a much broader set of counterparties and against a much wider set of collateral than had previously been the case in its regular open market operations. In the following months, additional facilities were introduced to expand further along these two dimensions. In March 2008 – at the time when Bear Stearns

5 In normal times, the ECB’s allotment decisions at its regular weekly refinancing operations implied a smooth accumulation of reserves by banks over the maintenance period. Following the emergence of market tensions, banks wished to “frontload” their reserve accumulation (i.e. to hold more reserves than the amount required on average at the start of the maintenance period and less at the end), in part to avoid being short at the end of the maintenance period.

6 i.e., increasing the volumes allotted in its longer-term refinancing operations (LTROs) at the expense of allotments in the main refinancing operations (MROs).

faced financing difficulties and was ultimately taken over by JP Morgan – the Federal Reserve created a standing credit facility for its primary dealers – institutions outside the set of depository institutions eligible for borrowing at the discount window. Moreover, the Federal Reserve offered these primary dealers the opportunity to borrow liquid Treasury securities against the collateral of illiquid assets held on their balance sheets (notably RMBSSs).

How can one explain the diversity of measures adopted in the face of the initial emergence of money market tensions, despite the common objectives of such non-standard measures? A crucial part of the explanation lies in different starting conditions. For example, even prior to the crisis, the ECB was conducting large regular refinancing operations – allotments in its weekly main refinancing operation (MRO) were around EUR 300bn. By contrast, the Federal Reserve’s regular refinancing operations were much smaller (in the region of USD 30bn), since the bulk of the counterpart to the note issue on the Federal Reserve balance sheet took the form of outright holdings of US Treasury securities. Similarly, the ECB had always had a very wide set of eligible counterparties (approaching 2000 credit institutions had the facility to bid at the weekly operations, of which around 300 regularly did so), whereas at the Federal Reserve only a small number of primary dealers (around 20) were able to bid at its daily tenders. And, in part because of the legacy of the diverse set of collateral systems inherited from the pre-Monetary Union period, a very broad range of assets – notably including asset-backed securities – were eligible as collateral in Eurosystem operations, whereas collateral for the Federal Reserve’s regular operations was much more limited (largely to US Treasuries and government agency bonds).

Relatively modest innovations within the ECB’s existing framework were therefore sufficient to manage the money market tensions, whereas more substantial changes were required in the US. Indeed, in many respects the introduction of new facilities by the Federal Reserve can be understood as an attempt to mimic the possibilities for central bank intermediation and refinancing offered by the ECB’s regular operations (cf. Bullard, 2009). It gave anonymous access to liquidity to a very large number of counterparties (all depository institutions that had access to the Federal Reserve’s primary credit facility or “discount window”) against a very broad range of collateral. The anonymous character of obtaining liquidity through the TAF was crucial, at a time when fear of the “stigma” associated with recourse to standing facilities in a market subject to informational asymmetries and adverse selection was high.

Moreover, the asset swap schemes introduced in the US and UK allowed illiquid assets to be taken off bank balance sheets and replaced by liquid securities that could be used as collateral in interbank transactions. Since the ECB accepted a large number of such assets as collateral in its own operations, there was little need for such asset swaps. Support for the view that the various and apparently diverse measures introduced by the three central banks were similar in substance is provided by the obvious co-movement of money market spreads during the August 2007 - September 2008 period (shown in Figure 2).

While the refinements to liquidity management described above were the main measures taken to address the initial emergence of money market tensions, in a number of cases central banks had to undertake further exceptional measures to support specific financial institutions in difficulty. Of special note is the case of Bear Stearns, which – after facing serious financing difficulties – was taken over by JP Morgan in March 2008. In facilitating this take over, the Federal Reserve provided financing to a special purpose vehicle that assumed the problem assets on the Bear Stearns balance sheet.

The success of this broad set of liquidity measures in containing the rise in money market interest rate spreads is illustrated in Figure 2. A number of studies have attempted to estimate the impact of liquidity measures using econometric event studies.<sup>7</sup> While the relative importance of liquidity and credit risk remains uncertain, the available studies suggest that the significant measures taken by central banks from August 2007 onwards did serve to contain the tensions in the market. Nonetheless – as reflected most visibly in the Bear Stearns case mentioned above – underlying problems in the financial sector persisted, with weak balance sheets, a need for capital replenishment and uncertainties surrounding the value and liquidity of “toxic assets” to the fore. While the functioning of the money market appeared to have improved somewhat as a consequence of central bank actions, risks in the financial sector remained significant.

### 3.2. Crisis: From mid-September 2008

These underlying weaknesses became manifest with the failure of Lehman Bros. in mid-September 2008. Whether this was simply the trigger for events that were anyway inevitable given the weakness of the banking system or a more important causal factor in its own right is difficult to ascertain (and likely to remain so). Suffice to say that, following the failure of Lehman, financial tensions intensified significantly.

One symptom of the panic then gripping financial markets was the further substantial rise in money market interest rate spreads, to levels not seen even at the height of the post-August 2007 tensions. At their peak following Lehman’s collapse, the spread between unsecured deposit rates (EURIBOR) and (secure) overnight indexed swap (OIS) rates at the three-month maturity approached 200 basis points in the euro area – and the equivalent spreads were even higher in the US and UK (see Figure 2).<sup>8</sup>

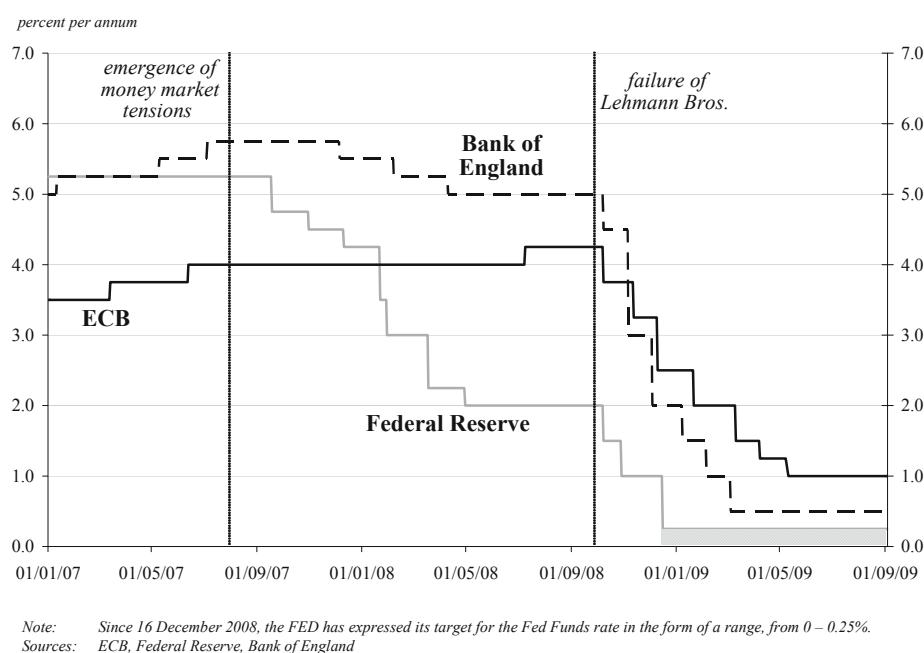
Central bank action following these events has to be understood as one part of a broader response by the policy authorities. Given the solvency issues that arose in many financial institutions, the fiscal authorities also needed to be mobilized to stabilize the financial sector. The passage of the troubled asset relief programme (TARP) in the US and the commitment of significant fiscal resources to support the banking system in Europe were important steps taken in early October 2008. Specific examples are American authorities’ bail-out of AIG, the rescues of Fortis and Dexia banking groups by European governments and the restructuring of the UK banking sector with the merger of leading players brokered by the government. Fiscal stimulus to support demand was also significant on both sides of the Atlantic.

Here we consider the central banks’ response. Interest rates were also cut significantly in the face of financial panic. On the 8 October 2008, the ECB, Federal Reserve and Bank of England (in conjunction with other leading central banks) embarked on a coordinated 50 basis point cut in their key policy rates (see Figure 3). Although the pace of subsequent cuts varied somewhat, by the spring of 2009 very short-term money market rates in all three jurisdictions were close to zero (even if the changes in key policy rates exhibited somewhat more heterogeneity, for reasons to be explained). And as market rates reached such very low levels, consideration of the possible implications of a lower bound on nominal interest rates increasingly entered policy discussions.

7 See Taylor and Williams (2008), McAndrews, et al. (2008), Wu (2008) and Christensen, et al. (2009).

8 These spreads form one basis for the empirical exercise conducted in Section 5.

**Figure 3: Evolution of key policy rates**



Our focus remains the effects of non-standard measures (rather than changes in key policy rates). After describing the non-standard measures taken by the three central banks, we demonstrate: first, that their impact on the size and composition of the central bank balance sheets was more similar across the three jurisdictions than has been typically suggested by observers thus far; and second, that differences in the actions taken by central banks reflected, to a large extent, differences in financial structure across countries, with implications for whether they could operate effectively with traditional counterparties or needed to innovate in that regard.

All three central banks undertook unprecedented actions with regard to the size and composition of their balance sheets. Initially, the motivation for such measures followed that which had underpinned the interventions after August 2007, namely to support market functioning through increasing central bank intermediation and to balance sheet pressures on financial institutions. Only the scale of such activities increased. As market activity froze, it became imperative to help banks manage the illiquid assets on their balance sheets: not only did such assets threaten the extension of new credit, their forced disposal would have created a “fire sale” adding to the downward pressure on asset prices that was already reducing available private collateral and eroding bank capital. Subsequently, as the level of interest rates fell, in some cases the motivation for such balance sheet actions shifted towards substituting for interest rate cuts (rather than maintaining financial market functioning), as the scope for conventional interest rate easing diminished.

Against this background, how do the actual measures introduced match up to the text book definitions provided in Section 2? As already recognised, prior to the Lehman failure the liquidity measures employed closely resemble text book qualitative easing: no aggregate expansion of the balance sheet, but rather change in the composition of its asset side. By contrast, from September 2008 onwards, the non-standard measures employed by the three central banks are no longer easily characterized as either one or the other text book case described in Section 2. First, the measures taken embodied both changes in the composition of the asset side and an overall expansion

of the balance sheet. While the means varied across central banks, the outcome was one where elements of both quantitative and qualitative easing were employed (even if the rhetorical emphasis placed on the two components varied across jurisdictions and over time). Second, on the liability side a number of elements were introduced that were not envisaged in the text book framework, such as the increase of government deposits at the central bank. And third, on the asset side the nature of unconventional operations varied across central banks: from simply increasing the maturity of outstanding liquidity-providing operations in the case of the ECB, to purchasing novel private assets (such as asset-backed securities) at the Federal Reserve.

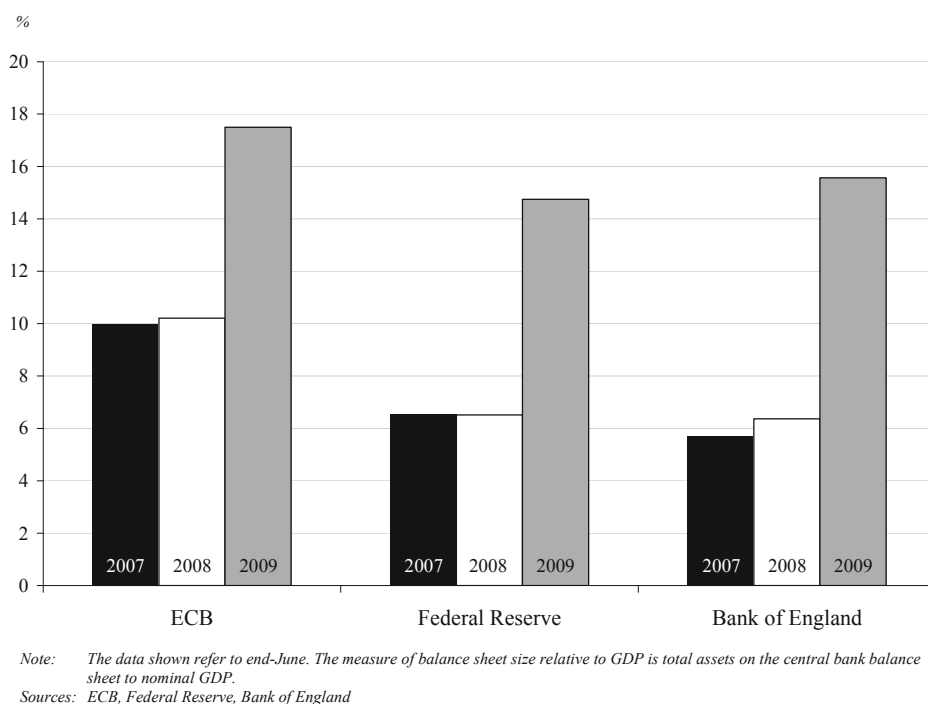
What is striking about the balance sheet evolution of these three central banks is that, despite significant differences in rhetoric and operational technique, there are obvious broad similarities in the approaches adopted. In particular, the timing of the balance sheet expansion is coincident; the nature of liability expansion – with a focus on accumulation of remunerated reserves – is very similar; and, although the specific nature of assets accumulated varied in line with the structure of the financial system, the increase in “unconventional” assets at the expense of conventional assets is common.

This notwithstanding, after the failure of Lehman Bros. comment has focused on the significant cross-country differences observed in the magnitude of changes to central bank balance sheets. For example, the total size of the Federal Reserve and Bank of England balance sheets have more than doubled since mid-September 2008, whereas that of the Eurosystem has increased by a more modest 60% (see Figures 5, 7 and 8). Yet such differences give a misleading impression of variation in central bank actions, since they neglect the variation in starting points. Given the much larger initial size of the Eurosystem balance sheet, the increase in financing needed to accommodate the greater demand for central bank liquidity and intermediation as the private interbank market seized up was proportionally smaller. Figure 4 demonstrates that the size of central bank balance sheets (relative to GDP) was relatively similar across the three jurisdictions considered after their response to Lehman’s demise, consistent with the view that the magnitude of changes largely reflected the different initial conditions.

If the impact on the composition and (eventual) size of central banks’ balance sheets was similar, greater diversity was demonstrated with regard to the mode of implementation and, in particular, the choice of counterparty. The ECB continued to operate largely via the banking sector, overwhelmingly in the form of repo operations. Even the relatively modest outright purchases of securities made by the Eurosystem were intended to improve bank funding conditions by reactivating the covered bond market. By contrast, the Federal Reserve undertook a very large volume of outright purchases of Treasury and, especially, asset-backed securities from a broader range of market counterparties, including non-banks. The Bank of England also engaged in significant outright purchases (strictly speaking, as an agent of HM Treasury) from a broad range of market counterparties going beyond banks. Indeed, the Bank of England attempted to target gilt purchases from the non-financial private sector.



**Figure 4: Central bank balance sheets relative to GDP**



Two broad explanations of these different approaches can be offered (corresponding to issues raised in Section 2 above): first, differences in financial market structure, which influenced decisions on whether the banking system should be supported or by-passed by the non-standard measures; and second, attitudes towards whether quantitative measures were needed to alleviate concerns about the effectiveness of monetary policy as the lower bound on nominal interest rates approached.

As regards the role of financial structure, given the overwhelming importance of banks as providers of external financing to firms and households in the euro area, the ECB had little alternative to work through the banking system and thus continue to operate largely via its regular counterparties. By contrast, the market-centred financial system in the United States implies that banks are a less important source of external funds and thus that working solely through the banking system – which was itself impaired – risked failing to ensure a flow of credit to the broader non-financial sector. As a consequence, the Federal Reserve set out to by-pass the banks, circumventing its conventional counterparties.

Moreover, the unbundling of the various components of loan making process had proceeded much further in the United States than in the euro area. By implication, direct interventions in financial markets by the Federal Reserve – such as the purchase of residential mortgage backed securities (RMBS) – were required to bridge the institutional “gap” that had emerged between the origination of loans, their initial financing and their ultimate securitization and sale in the market. The equivalent euro area transactions remained internalised within a single financial institution that both originated, financed and (when possible) securitized the underlying mortgage loans. Recourse to Eurosystem operations by conventional counterparties, where RMBS remained eligible collateral,

was therefore sufficient to prevent a complete freezing of the credit creation process.<sup>9</sup> By contrast, in the US the Federal Reserve was forced to undertake a much greater “market making” role, so as to ensure that the links in this intermediation chain remained intact. Such details of the intermediation process thus influenced the design of non-standard measures as much as the overall structure of the financial system.

Turning to questions related to the lower bound, to the extent that non-standard measures were seen as a substitute for interest rate cuts as a lower bound on nominal rates approached, the Federal Reserve and, in particular, the Bank of England emphasised the desirability of purchasing assets from non-bank counterparties. Through such measures, the impact of quantitative measures on private portfolio choices (and thus on asset prices and spending) could work more effectively, since the danger that the liquidity injected would simply be held passively in the banking system would be reduced. At the time of writing, the success of such an approach remains open to question.

By their nature, these non-standard measures increased the complexity of communicating the monetary policy stance. Precisely because of their novelty, a new mode of communication was required – even if the specifics varied from one central bank to another, depending on the details of the measures introduced – and this required some learning from both sides.

Against this background, the remainder of this sub-section offers a more detailed description of the actions of the three central banks following the failure of Lehman Bros., with an emphasis on the euro area.

### **3.2.1. Euro area**

Soon after the coordinated interest rate cut on 8 October, the ECB announced several important innovations in its operational procedures (see Trichet, 2009; ECB, 2010).

First and foremost, it adopted a fixed rate / full allotment (FRFA) tender procedure in its regular monetary policy operations. Through so doing, it forewent the ability to determine the quantity of liquidity provided to the market by deferring that decision to its counterparties. By providing certainty on the availability of central bank liquidity (with regards to both quantity and price), this measure helped to stabilise the banking sector at a time of high stress.

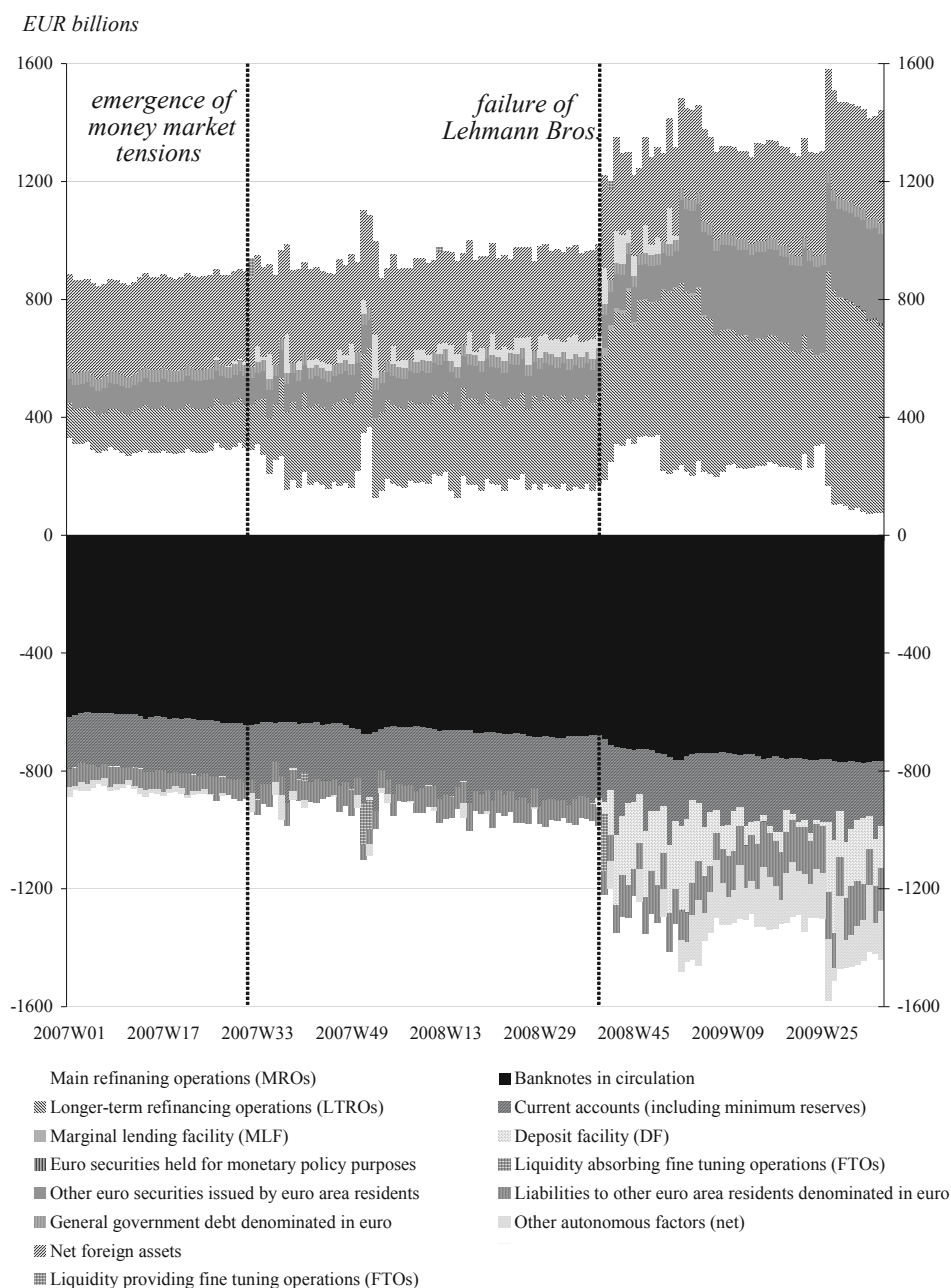
Second, the ECB expanded its list of eligible collateral, to include securities (other than ABS) rated BBB or higher, while also further lengthening the average maturity of its outstanding operations.

Third, over time the ECB increased the number and variety of Eurosystem longer-term operations. Innovations included: the introduction of a so-called maintenance period operation (i.e. a repo operation at the start of the maintenance period that matures at the end of the maintenance period, with an implied maturity of around one month); and the introduction of LTROs with six month maturity.

Taken together, these measures considerably expanded the scope for central bank intermediation to substitute for a money market subject to severe disruption (González-Páramo, 2009). In particular, the full allotment procedure allowed the market to determine the volume of such intermediation itself, rather than the ECB

<sup>9</sup> Indeed, banks were able to securitize mortgage loans already held on their balance sheets via related special purpose vehicles, hold the resulting securities (so-called “retained securitization”) and use them as collateral in Eurosystem operations.

Figure 5: Evolution of the Eurosystem balance sheet



Source: ECB

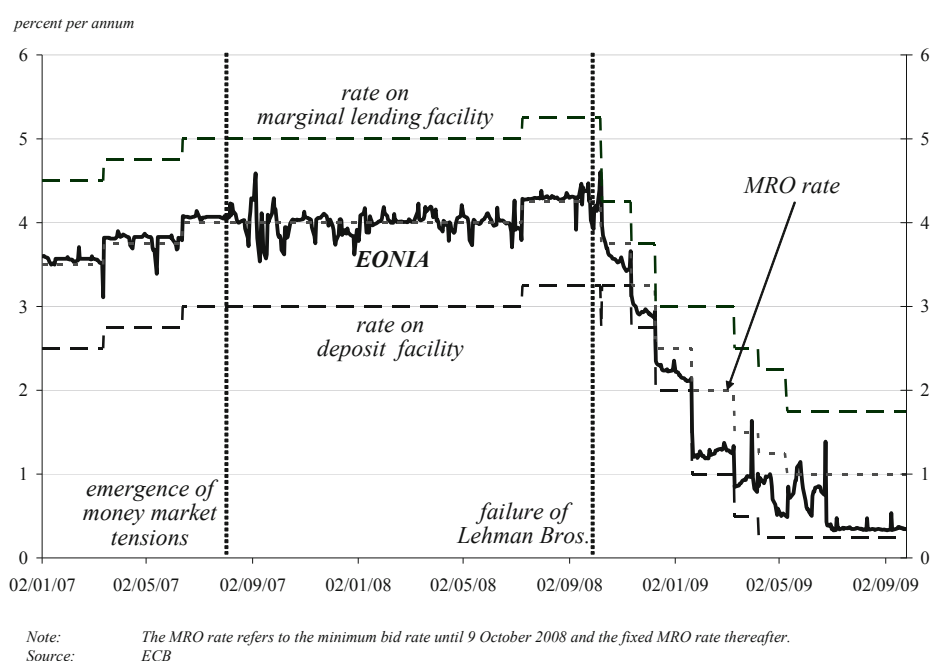
making a choice as to what magnitude of intermediation it would engage in. Moreover, bank counterparties to the Eurosystem operations were able to refinance parts of their balance sheets at the central bank.<sup>10</sup> In the extremely difficult market conditions that followed the failure of Lehman Bros., there can be little doubt that this facility provided significant comfort and support to the banking sector and thus, particularly given the bank-centric nature of the financial system, to financial stability in the euro area.

<sup>10</sup> One particular feature of this more general phenomenon was so-called “retained securitization”, whereby banks transformed loans on their own balance sheet into ABS via related SPVs, and then held the resulting security to use as collateral in the Eurosystem operations. Mortgage loans, for example, could thus be refinanced at the ECB.

Reflecting the need for such intermediation in the environment then prevailing, demand for central bank liquidity at the ECB's operations was substantial. Participation at the tenders also increased, with around 1000 counterparties bidding at the peak. Indeed, demand was so large that it exceeded the aggregate liquidity needs of the banking sector consistent with the fulfilment of reserve requirements over the maintenance period as a whole. The ECB chose to reabsorb the liquidity in excess of that required to fulfil minimum reserves through recourse to the deposit facility, rather than conducting fine tuning operations. As a result, through voluntary recourse to the deposit facility, counterparties' holdings at that facility – and thus the monetary base, defined as the sum of currency in circulation and reserves held at the central bank (including at the deposit facility) – increased substantially (see Figure 5).

Given the strength of counterparty demand and the decision not to reabsorb excess liquidity via exceptional draining operations, a chronic situation of ample liquidity emerged in the euro money market. As a result, the overnight money market interest rate (EONIA) moved systematically away from the rate at the main weekly tenders (the so-called MRO rate, which hitherto had been seen as the ECB's key policy rate) and fell towards the rate on the deposit facility (see Figure 6). As such, the MRO rate became a less effective summary of the monetary policy stance, as the emergence of spreads in the money market rendered it a less effective basis for assessing market rates and the starting point of the transmission mechanism.

**Figure 6: Evolution of the EONIA relative to the ECB key interest rates**



When the full allotment at fixed rate tender procedure was introduced in its operations, the ECB also reduced the width of its interest rate corridor (defined by the rates on the marginal lending facility and deposit facility) to  $\pm 50$  basis points from its normal  $\pm 100$  basis points. This represented an attempt to avoid too great a fall in the overnight rates and maintain the MRO rate as a meaningful signal of the monetary policy stance. However, in

January 2009, having experienced a fall in activity in the overnight money market associated with this narrower corridor,<sup>11</sup> the ECB decided to re-widen the interest rate corridor to  $\pm 100$  basis points and thereby to accept a significant departure of the overnight market rate from the MRO rate.<sup>12</sup> Over time, it was recognised that the MRO rate no longer constituted a complete indicator of the monetary policy stance and that, in the exceptional times being faced, the stance was to be understood in terms of the level of market rates at various maturities, in addition to the MRO rate (see ECB, 2010).<sup>13</sup> Indeed, with the EONIA persistently below the MRO rate, money market rates of all types and at all maturities adjusted downwards. Thus the specific liquidity measures introduced by the ECB exerted a clear effect on the level of short-term interest rates – and thus the monetary policy stance – from autumn 2008 onwards.

In May 2009, the ECB announced that it would undertake three repo operations with a one-year maturity, further extending its support of banks' credit creation. These operations were also conducted using a fixed rate procedure with full allotment. The attractiveness of this facility resulted in a very large demand (and allotment) at the first, June operation (slightly less than EUR 450bn). The substantial quantity of liquidity provided maintained the downward pressure on EONIA, which fluctuated 60 - 70 basis points below the MRO rate rather than at a spread of 3-10 basis points above the MRO rate characteristic of normal times.<sup>14</sup> Moreover, the long maturity of the fixed rate operation was interpreted by some as a signal of future interest rate intentions (and thus an attempt to "flatten the yield curve" and loosen overall financing conditions while holding very short-term rates unchanged), even if the ECB was at pains to make clear that it would never pre-commit to a path of future interest rates.

In concert with the announcement of these one-year operations, the ECB also announced that it would purchase EUR 60bn of bank covered bonds over the course of the subsequent year. The size of these purchases was modest, both in relation to the overall size of the covered bond market and the size of the ECB's own balance sheet. The stated purpose of the covered bond purchase programme was to act as a catalyst for the recovery of the private transactions in the market, rather than act as a replacement for such transactions. Its approach thus differed from that adopted in the money market, where ECB interventions aimed at offering the possibility of central bank intermediation to replace private transactions that were no longer taking place. Moreover, covered bond purchases were viewed as part of a consistent strategy associated with the other measures described above, which focused on easing bank funding conditions and promoting credit creation through the banking system rather than trying to by-pass it. By the end of September 2009, covered bond purchases totalled around EUR 12bn.<sup>15</sup> Despite this modest amount, these purchases appear to have exerted a positive influence on primary

11 In principle, a narrower corridor implicitly made intermediation over the central bank balance sheet cheaper relative to market intermediation (the corridor was akin to the 'bid / ask' spread in private markets).

12 On reducing the MRO rate by 25 basis points to 1% in May 2009, the ECB left the deposit rate at 0.25%, thereby again narrowing the corridor, this time to  $\pm 75$  basis points (as the marginal lending rate was simultaneously reduced by 50 basis points).

13 In particular, the ECB stated: "in these exceptional circumstances, the signalling of the monetary policy stance has become more complex. ... the rate [on the deposit facility] has played a more prominent role than in the past with respect to the EONIA and other very short-term money market interest rates." (ECB, 2010; p. 69).

14 These spreads form another basis of the empirical exercise conducted in Section 5.

15 The covered bond purchase programme was completed in June 2010, when the full EUR 60bn envisaged had been purchased. In May 2010, the Eurosystem introduced the Securities Market Programme (SMP), in the face of turmoil in sovereign debt markets. The SMP resulted in EUR 61bn purchases of government debt through end-September 2010. Compared with the outright asset purchases by the Federal Reserve (amounting to USD 1.3tr) or the Bank of England (GBP 200bn), even including the SMP, the Eurosystem's purchases were of more modest magnitude, certainly when compared with the size of the economy and/or the pre-crisis size of the central bank balance sheet.

market issuance and narrowed credit spreads in the specific market segment, even if secondary market trading remains low by normal standards.

Finally, in response to the Lehman failure, the ECB (and other central banks, including the Bank of England) opened swap lines with the Federal Reserve in order to ensure a smoother distribution of US dollar liquidity to European and Asian banks. The proceeds of these swaps were then provided to non-US resident banks.<sup>16</sup> In the ECB case, US dollars were offered to its counterparties against regular Eurosystem collateral. These operations also adopted a fixed rate tender procedure with full allotment.

Taken together, these measures have been labelled the ECB's "enhanced credit support".<sup>17</sup> Their impact on the ECB's balance sheet is shown in Figure 5. To sum up, a number of points are worthy of note: (1) balance sheet expansion in excess of the trend increase in banknotes only started after the failure of Lehman; (2) on the liabilities side, balance sheet expansion was largely reflected in recourse to the deposit facility; (3) on the asset side, expansion of the balance sheet was largely associated with longer-term refinancing operations; and (4) the magnitude of outright purchases is negligible.

### 3.2.2. United States

In the US, the Federal Reserve also moved to expand its balance sheet significantly after the failure of Lehman Bros. On the liability side, balance sheet expansion was reflected in an increase in both deposits held by the US treasury at the Federal Reserve and bank reserves. As part of the TARP legislation passed by Congress in its emergency response to the crisis, the Federal Reserve was endowed with the power to pay interest on bank reserves (thereby mimicking ECB practice since the start of Monetary Union<sup>18</sup>). This allowed the accumulation of reserves at the Federal Reserve to take place without market interest rates departing substantially from the Fed Funds rate target set by the FOMC. However, because significant players in the overnight market did not have access to this remunerated deposit facility, in practice it proved difficult to stabilize the dollar overnight rate. Indeed, the Federal Reserve ultimately decided to announce a target band of 0 – 0.25% for the Fed Funds rate (even with reserves offering a return of 0.25%), reflecting its difficulty in steering the rate closely in this environment.

Looking forward, the introduction of reserve remuneration represents a significant step in the Federal Reserve's implementation of monetary policy, bringing it more closely in line with practice at the ECB and Bank of England. Such remuneration allows the level of short-term interest rates (a measure of the stance of conventional monetary policy) to be set independently of choices made in terms of liquidity provision. As a result, in terms of exiting from the current non-standard measures, remuneration of reserves provides the Federal Reserve with greater flexibility, since it is free to choose the sequencing of changes in liquidity management and changes in interest rates. Moreover, remuneration of reserves allows excess liquidity to be re-absorbed by the Federal Reserve in a quasi-automatic manner at a standing facility, where the rate on that facility is the policy rate.

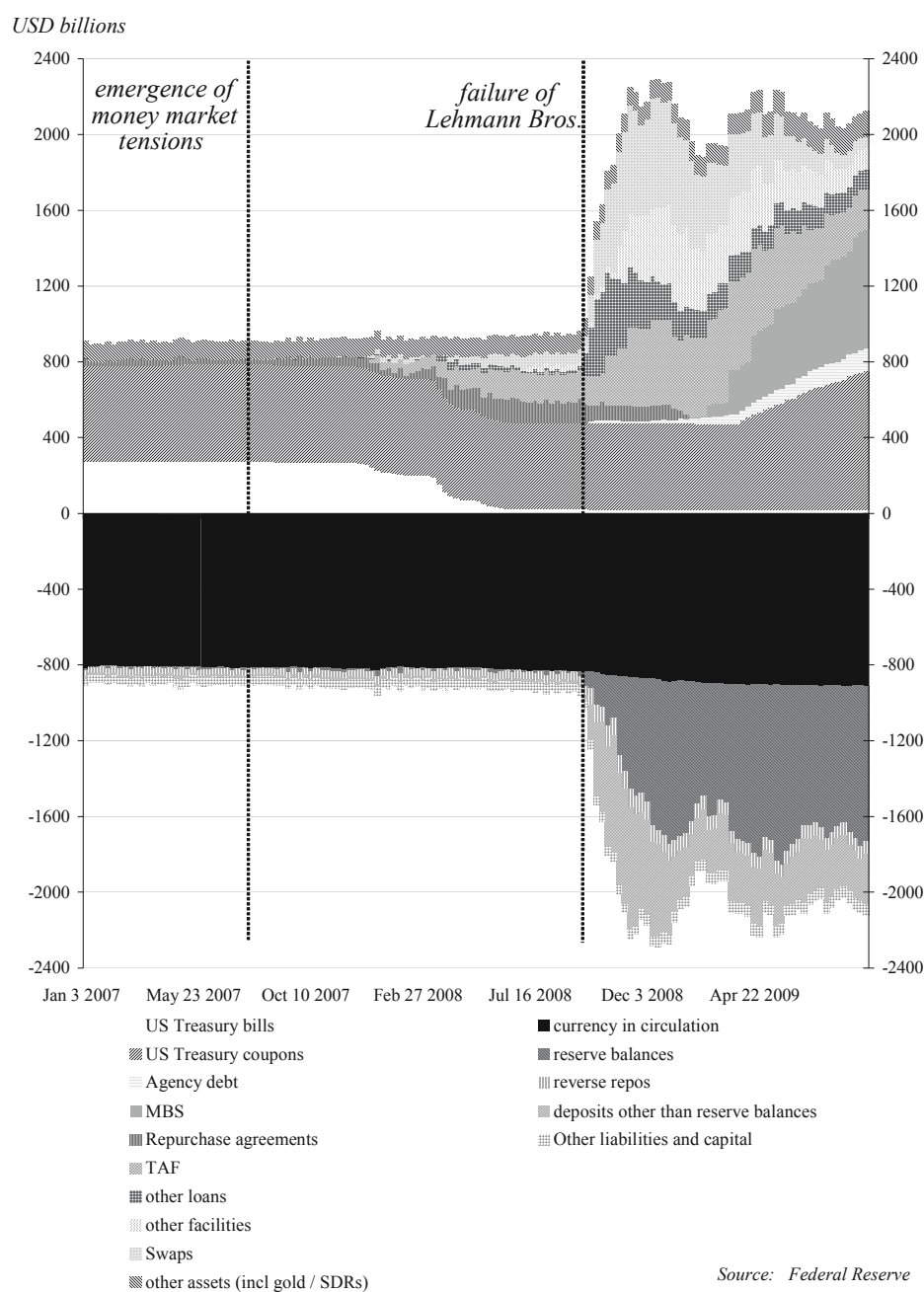
16 For example, on the basis of dollars obtained through a swap with the Federal Reserve, the ECB offered dollar liquidity to its own European counterparties against its regular collateral in dollar tender operations.

17 See, for example, the description of the ECB measures offered in Trichet (2009).

18 Although, as discussed below, the Federal Reserve remunerated both required and excess reserves. By implication, their measure can be interpreted as shifting the rate offered on the deposit facility (in Eurosystem language) up to the 'policy rate', thereby narrowing the interest rate corridor (to zero) from below.



Figure 7: Evolution of the Federal Reserve balance sheet



Turning to the evolution of the Federal Reserve's balance sheet, following Lehman's demise the Federal Reserve undertook large outright purchases of a variety of securities, thereby expanding and changing the composition of its asset holdings (see Figure 7). A whole series of facilities were introduced to support various segments of the financial market and specific institutional sectors. In particular, significant purchases of agency debt<sup>19</sup> and asset-backed securities were made, in an attempt to stabilize these markets and prevent the seizing up of credit creation.

19 Notably debt issued by the government-sponsored agencies active in the mortgage market, usually referred to as 'Freddie Mac' and 'Fannie Mae'.

This process of direct intervention in specific financial markets was labelled “credit easing”. It was seen as a natural continuation of the policies pursued by the Federal Reserve prior to the Lehman failure, which also involved a reconfiguration of the asset side of the Federal Reserve’s balance sheet as non-conventional assets (e.g. TAF loans) replaced conventional assets (Treasury securities). The intensification of financial market tensions in mid-September 2008 simply became larger in scale and thus implied an expansion of the overall balance sheet in order to accommodate the larger required asset purchases. This approach was distinguished from the “quantitative easing” pursued by Japan at the turn of the century, which had focused on expanding the liability side of the Bank of Japan’s balance sheet and was seen by many observers having been relatively ineffective.<sup>20</sup>

However, by March 2009 – as market conditions reached their nadir – the Federal Reserve prepared to combine the “credit easing” approach of targeted (even if large) market interventions described above with a broader attempt to expand its balance sheet. A large asset purchase scheme was initiated, which will imply the purchase of USD 1.75tr of assets (USD 1.25tr of agency debt, USD 300bn of Treasuries and USD 200bn of other assets) outright by the end of the first quarter of 2010. These volumes are without historical precedent and dwarf the increases in the Eurosystem’s balance sheet (and still more the outright purchases made by the ECB, which are tiny in comparison). However, when judging these policies in a comparative perspective, it is important to keep in mind that the Eurosystem’s balance sheet was initially much larger. Both at current market exchange rates and in relation to GDP, the Federal Reserve and ECB balance sheets are broadly at comparable magnitudes in levels, despite the much larger increase seen in the US over the past year (see Figure 4 above).

Also appearing on the asset side of the Federal Reserve’s balance sheet are the swaps with other central banks, already discussed above. It should also be mentioned that, as in the Bear Stearns case, the Federal Reserve was closely involved in a number of “rescue schemes” for specific financial institutions. For example, it provided loans to facilitate rescue of AIG (an insurance company) immediately after Lehman’s failure. These actions – most of which were indemnified by the US Treasury – resulted in the creation of a number of other “off balance sheet vehicles” that were financed by the Federal Reserve.

### 3.2.3. United Kingdom

The evolution of the Bank of England balance sheet demonstrates a number of similar features. Again, balance sheet expansion only starts in earnest after the failure of Lehman (see Figure 8).

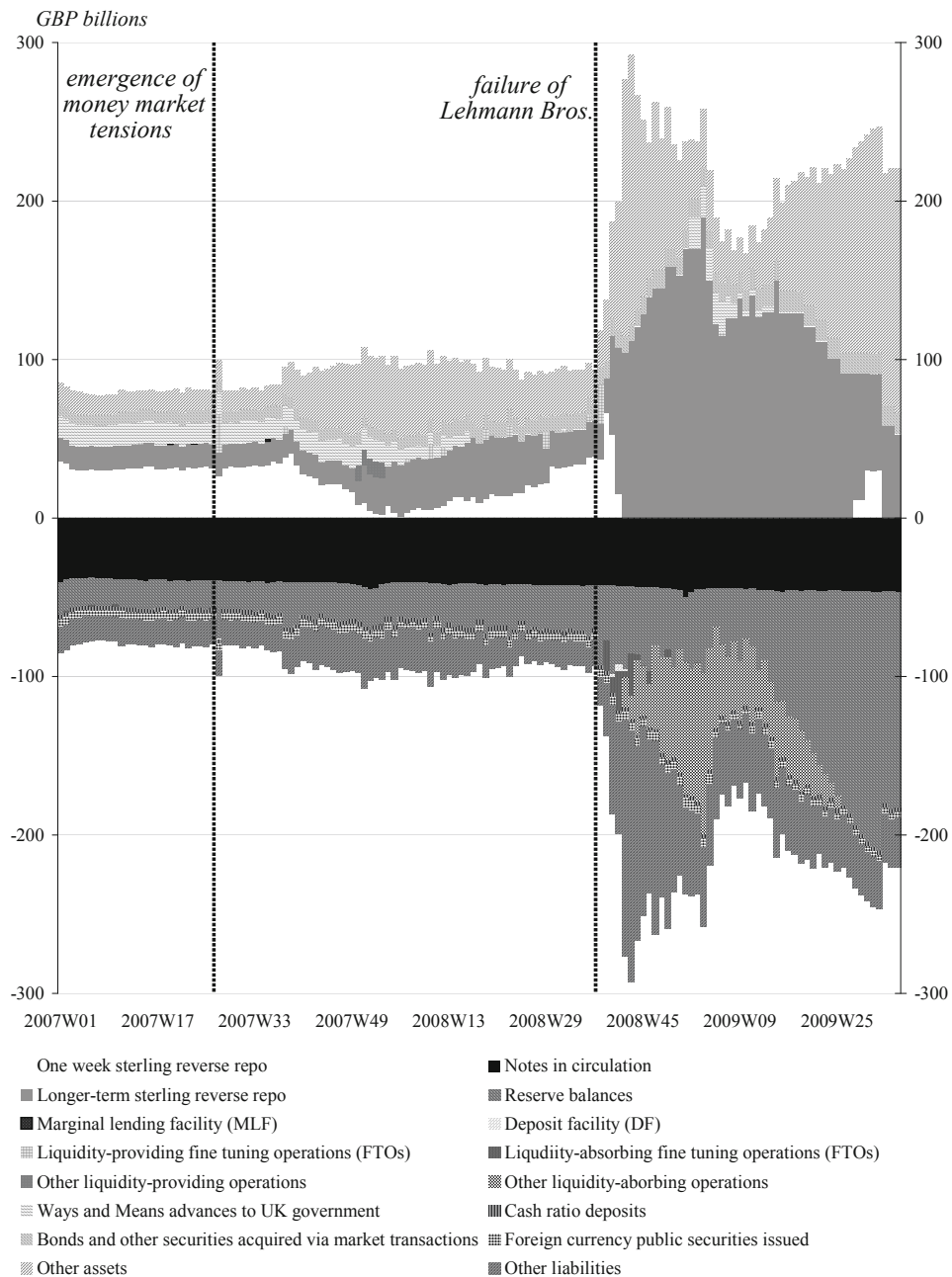
On the liability side, it largely reflects an increase in recourse to the deposit facility, which is remunerated in a similar manner to that of the ECB.<sup>21</sup> On the asset side, the Bank of England initially also followed an approach which emphasized longer-term repos, but from early 2009 it started to undertake large asset purchases. In order to protect the Bank of England from the financial risks associated with such balance sheet expansion, these purchases were undertaken by an off balance sheet vehicle with government guarantees that was financed by loans from the Bank of England. These latter measures were labelled “quantitative easing”; relative to the ECB

<sup>20</sup> See Bernanke (2009), where this distinction was emphasised.

<sup>21</sup> Although, as at the Federal Reserve, during the crisis period *both* required *and* excess reserves were remunerated at the policy rate in the UK, implying a narrowing of the interest rate corridor from below and thereby ensuring that very short-term money market interest rates do not fall below the policy rate.

and Federal Reserve, after the introduction of its asset purchase facility, the Bank of England placed more emphasis on the expansion of the liability side of its balance sheet, rather than the composition and size of the asset side.<sup>22</sup>

**Figure 8: Evolution of the Bank of England balance sheet**



Source: Bank of England

22 See Bean (2009) for a more complete discussion.

#### 4. TRANSMISSION MECHANISMS

Having described in some detail the non-standard measures introduced by the three central banks considered in this paper, we now investigate their impact on the economy. In the interests of brevity, we focus our empirical investigation on the euro area. Extending the analysis to the US and UK is left for future work.

As we have seen, the non-standard measures introduced by the ECB since the autumn of 2008 have resulted in a significant increase of the euro area monetary base. However, this increase has not been translated into an increase in broad money (M2, M3) because the so-called “money multiplier” (i.e. the ratio of broad money to the monetary base) has declined substantially. Nonetheless, non-standard measures have had a significant effect on the euro area economy, acting via interest rates.

Three channels of transmission via interest rates stand out. First, non-standard measures may influence the level of very short-term interest rates (notably the overnight rate) directly, through “liquidity effects” in the money market. In other words, to the extent that such measures result in excess central bank liquidity accumulating in the market, non-standard measures can open up a spread between the “key policy rate” (i.e. the MRO rate in the ECB context) and the overnight market rate (EONIA) that forms the basis for pricing financial instruments of more relevance for macroeconomic developments. Second, non-standard measures may contain and/or reduce the spreads that emerged in the money market. In this way, the level of important market interest rates (such as the EURIBOR or LIBOR, which form the basis for many private credit contracts) can be reduced for a given level of the key policy rates, thereby stimulating private spending. Efforts to offer central bank intermediation to support interbank transactions would work in this direction and – as shown in Figure 2 – appear to have been relatively successful. Third, non-standard measures may serve to manage expectations of the path of future monetary policy decisions and thus affect the slope of the money market yield curve.

With this background in mind, in what follows we investigate the macroeconomic effects of variations in interest rate spreads, which themselves can be seen as the result of non-standard measures introduced by the ECB. If the relationships between macroeconomic variables and interest rates have remained relatively stable through the financial crisis, this component of the impact of non-standard measures can be evaluated using the same methods that are used to assess the effects of an interest rate change in normal times. In other words, by using non-standard measures to influence spreads, central banks have affected financing conditions. Via this channel, such measures affect the economy as a whole in a manner akin to that of a standard monetary policy shock.

Our exercise thus consists of constructing counterfactual paths for the main macroeconomic variables under two scenarios: (a) a no policy scenario (to be understood as a scenario where non-standard measures are not implemented); and (b) a policy scenario, where that spread is reduced by policy intervention through the introduction of non-standard measures (we assume that this scenario is captured by the path of money market rates observed in reality). These exercises are conducted on the basis of a monthly Bayesian vector autoregression (B-VAR) model of the euro area developed by Giannone, et al. (2009). This model includes the standard macroeconomic variables. Its novelty consists of including a more extensive modelling of monetary and credit variables, including a relatively broad set of interest rates and yields (see the Appendix for model details).

## 5. THE MACROECONOMIC IMPACT OF NON-STANDARD MEASURES

In normal times, the spread between the EONIA and the ECB's key policy rate at its main refinancing operation is small and positive. However, as explained in Section 3, as a response to the increased money market tensions following Lehman Bros.' collapse, the ECB's switch to fixed rate full allotment procedures in its operations resulted in the EONIA moving close to the lower bound of the interest rate corridor (set by the rate on the deposit facility) (see Figure 6). As a result, the MRO / EONIA spread widened and turned negative, falling to approximately 65bps. Moreover, the introduction of non-standard measures by the ECB also appears to have reduced the spread between the EURIBOR and OIS rates in the money market, reflecting central bank intermediation of interbank transactions as the market froze. Such measures may also have (other things equal) led to some flattening of the money market yield curve. For example, the introduction of 12-month operations at fixed rates is likely to have had such an effect.

In this section, we aim to assess the effects of non-standard monetary policy measures on some selected macroeconomic and financial variables. We do that by comparing two counterfactual scenarios. The counterfactual scenarios are forecasts of some selected policy-relevant variables exclusively conditional on specific paths of money market interest rates between November 2008 and August 2009.

In the no policy (**NP**) scenario we assume that the spreads between money market rates and the policy rate have remained as in October 2008 and the slope of the yield curve has not been affected by non standard policy measures. The difference between the observed path of money market rates and their value in the no policy scenario is assumed to reflect non standard monetary policy measures. Hence, the policy scenario (**P**) is one in which we forecast all variables of interest conditional exclusively on the true path of money market rates observed between November 2008 and August 2009. The rest of this section is devoted to further illustrate the exercise just outlined and its outcomes.

The Giannone, et al. (2009) model provides a very general and flexible representation of the euro area economy, which captures the dynamic interrelationships among the macroeconomy (real activity, nominal variables and confidence indicators), international factors (global activity and prices, exchange rates), capital markets (government bond rates and stock prices), money and credit. In particular, as regards developments in money and credit, the model includes bank loans broken down by sector (i.e. to non-financial corporations and households) and the monetary aggregates M1, M2 and M3. The corresponding interest rates – bank lending rates and the own rate of return on monetary aggregates – are also encompassed, as well as information on the term structure. More details on variable definition, transformations and parameterization are provided in the appendix.

Collecting all variables in the vector  $Y_t$ , we can write:

$$Y_t = \Theta_0 + \Theta_1 Y_{t-1} + \dots + \Theta_p Y_{t-p} + e_t$$

where  $e_t$  is a vector-white noise,  $\Theta_0$  a vector of constants and  $\Theta_1$  to  $\Theta_p$  the matrices describing the relationships between  $Y_t$  and its  $p$  lags. We estimate the model parameters from January 1991 until the end of 2007, before the non-standard policies were implemented.

On the basis of the estimated parameters, we construct two conditional forecasts of the variables of interest for the period from November 2008 onwards, corresponding, respectively, to the policy and no policy scenarios.<sup>23</sup>

### 5.1. No policy scenario

The no policy scenario is thus based on the following technical assumptions regarding the evolution of money market spreads.

First, the counterfactual path of the EURIBOR 3-month rate for the period November 2008 to August 2009 corresponds to the ECB's key MRO rate with the addition of: (a) the positive spread EURIBOR / MRO rate spread observed in October 2008; and (b) the difference between the historical MRO rate / EONIA spread seen in the pre-crisis period and that observed between November 2008 and August 2009.

Second, the counterfactual for the 12-month EURIBOR corresponds to the ECB's key MRO rate with the addition of: (a) the positive spread observed between the EURIBOR 12-month rate and the MRO rate in October 2008; and (b) the effect of non-standard policy measures on the slope of the yield curve. The latter is assessed by estimating the VAR until 2007 (taking the view that this represents a "standard" monetary policy sample) and forecasting the 3-month EURIBOR for 3, 6 and 9 months ahead from November 2008 (which are seen as the model consistent path of short-term rates under standard policy). This counterfactual expected rate is then compared with actual expected policy rates computed using the forward rates implied by the Overnight Index Swaps (OIS). The effect of non-standard measures on the slope of the yield curve is computed as the difference between actual expected policy and (counterfactual) expected standard policy.

We compute the conditional expectation of the variables included in the VAR given the parameters of the models, past observations of all variables and the future paths of the interest rates in the no-policy scenario, i.e. the counterfactual EURIBOR at 3 and 12 month maturities. More precisely, for a generic variable  $y_t$  included in the vector  $Y_t$ , the algorithm computes the most likely path for the variable based on the estimated parameter values ( $\Theta$ ), the past and present of all the variables ( $Y_0 \dots Y_t$ ) and on the no policy future path of the two interest rates ( $i_{NP,t+1} \dots i_{NP,t+H}$ ) mentioned above, i.e.

$$E_{\Theta}(y_t | Y_0 \dots Y_t, i_{NP,t+1} \dots i_{NP,t+H})$$

### 5.2. Policy scenario

Our assumption is that non-standard monetary policy measures have affected the EURIBOR / MRO spreads and the slope of the yield curve in the period under analysis (November 2008 - August 2009). This amounts to saying that the difference between the no policy path of money market rates and the observed path of money market rates captures the effect of non standard monetary policy on the money market rates. Hence, in the policy scenario (**P**) conditional expectations of the variables in the VAR are computed by conditioning on the true path observed for the EURIBOR / MRO spread. That is, we compute a counterfactual scenario based on

23 Conditional forecasts are derived by using the Kalman Filter based algorithm developed in Banbura, et al. (2009).



the assumption that we observe only the true path of EURIBOR rates for the period November 2008 - August 2009 (and the model determines the paths of the other variables).

$$E_{\Theta}(y_t | Y_0 \dots Y_t, i_{P,t+1} \dots i_{P,t+H})$$

### 5.3. The impact of non-standard measures

In this exercise, the impact of non-standard measures for the generic variable  $y$  ( $DP_y$ ) is defined as the difference between the policy and the non-policy conditional expectations derived using the methods outlined above:

$$DP_y = E_{\Theta}(y_t | Y_0 \dots Y_t, i_{P,t+1} \dots i_{P,t+H}) - E_{\Theta}(y_t | Y_0 \dots Y_t, i_{NP,t+1} \dots i_{NP,t+H})$$

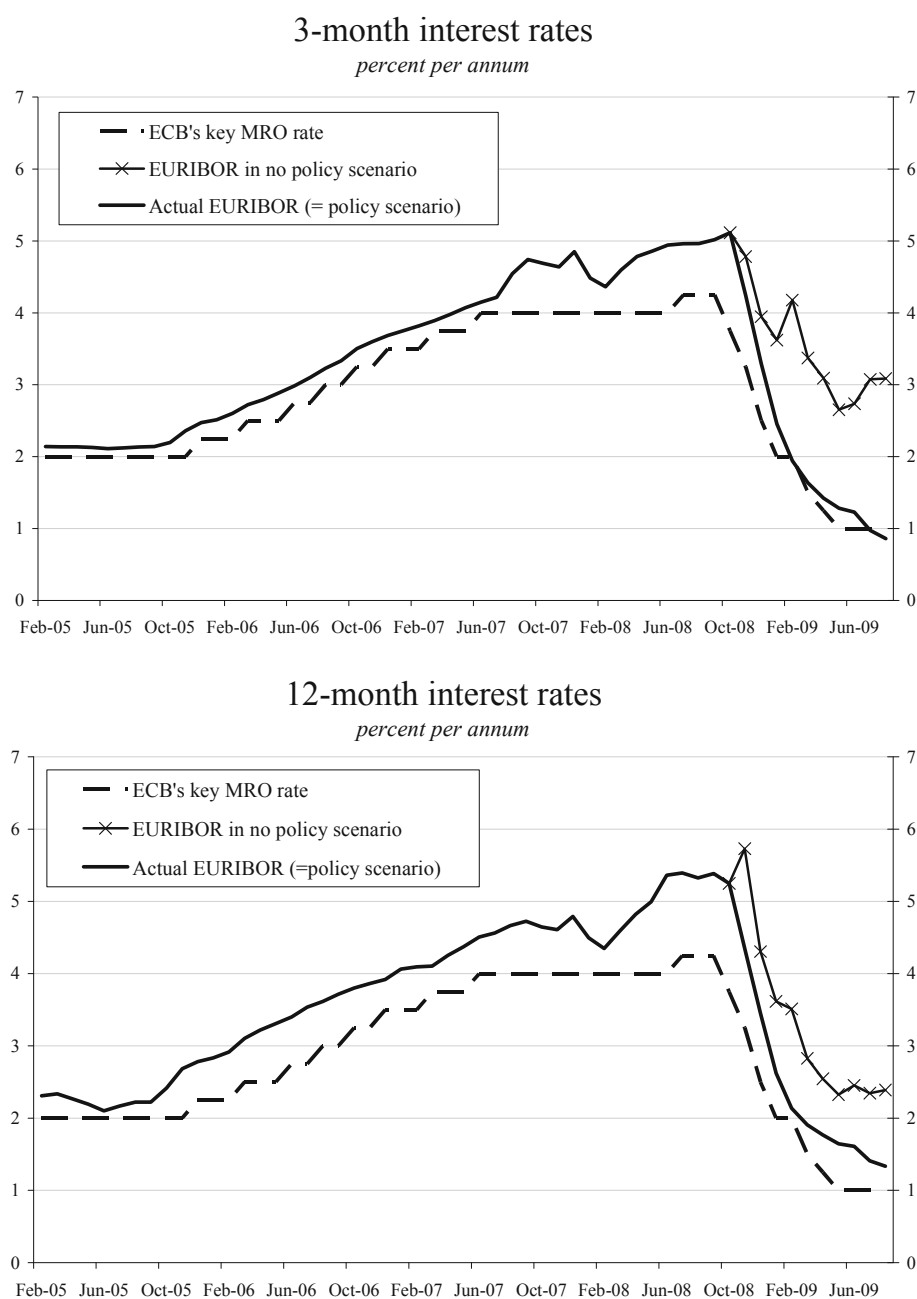
Of course, another – and arguably simpler – option would be to compare the outcome of the no policy scenario for the variable  $y$  with its observed values over the period between November 2008 and August 2009, rather than with the counterfactual outcomes based on the policy scenario. We choose to focus on  $DP_y$  as defined above because this is the only way to “identify” the effects of those factors that exclusively have an impact on money market rates and spreads, i.e. our proxy for non-standard measures. If we were to compare the no policy scenario outcomes with the observed values of  $y$ , we would be more likely to mix the effects of non-standard policy with all other sources of fluctuation in the dynamics of  $y$ , potentially unrelated to non-standard monetary policy measures.

A caveat on our exercise is that our method delivers interpretable results only under the assumption that the coefficients of the estimated model have not changed after 2008, as financial crisis struck. Only in this case can the difference in the conditional paths be interpreted as the result of non-standard measures rather than the effect of both the non-standard measures and changes in behavioural relationships. Giannone et al., (2009) provide results that indicate there is no evidence of a change in coefficients after 2008 in the euro area, thereby supporting the assumption on which our subsequent analysis relies.

Against this background, Figure 9 reports paths for the 3-month and 12-month EURIBOR in the policy and no policy scenarios.

Figure 10 illustrates our estimates of the impact of non-standard measures on the macroeconomic variables of interest: M1, M3, loans (for house purchase, or consumption and to non-financial corporations), inflation, unemployment and industrial production. The charts report the size of the effect (the solid line) and the effect normalized by the standard deviation of the variable (the dashed line). The charts show the year-on-year growth rates of the variables. A positive value of, say, 1 percentage point (pp) in the figures should be interpreted as a statement that non-standard policy measures account for a growth rate that is 1pp higher than we would observe in absence of non-standard policy. (An exception is unemployment, for which we report differences in levels.)

Figure 9: Interest rate paths in counterfactual simulations

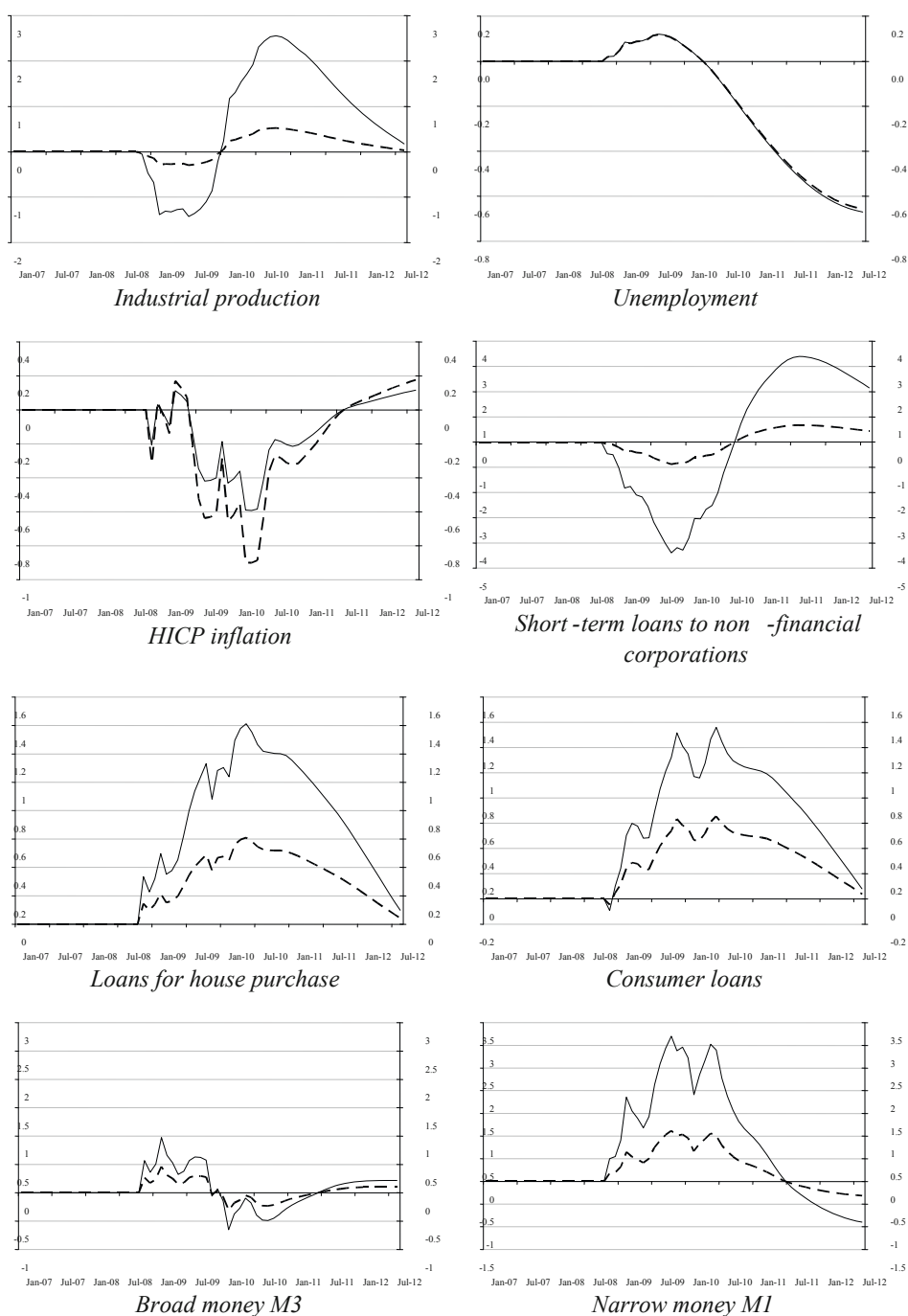


Source: ECB, authors' calculations.

We commence our analysis of these results with loans. The charts show that the effect of non-standard measures on consumer loans and loans for housing purchases is large and positive, while the effect on loans to non-financial corporations becomes positive only after a delay. It is interesting to note that these results are in line with what found by Giannone et al. (2009) for the effects of non-systematic standard monetary policy (i.e. unexpected short-term interest rate shocks): an exogenous interest rate cut affects loans to non-financial corporations negatively on impact, but positively with a lag; while the effect on consumer loans and loans for housing purposes is positive on impact. The lagging behaviour of loans to non-financial corporations with

Figure 10: Estimated impact of non-standard measures in B-VAR model

percentage points



Note: The vertical axis reports the difference (solid line) and standardized difference (dashed line) between the annual growth rates in the policy with respect to the no policy scenario of the variables indicated on the horizontal axis. The standardized difference is computed as the ratio between the difference and the standard deviation of the variable. The only exception is unemployment for which results are reported in terms of differences between levels. The vertical axis reports results in terms of percentage points.

respect to the business cycle and to a monetary policy shock is a well documented fact for both euro area and US data. For a discussion, see Christiano, et al. (1999), Den Haan, et al. (2007) and Giannone, et al. (2009). Various arguments have been advanced to explain this phenomenon, such as: the role of relationship banking, substitution into bank sources of external markets due to a lagged response of bank loan conditions relative to market conditions; cash flow squeezes on corporate borrowers at times of monetary policy tightening, etc.

While our results should therefore not be seen as surprising, in comparing them with impulse response functions estimated in the literature, we should keep in mind that our estimates are based on differences in counterfactual paths and cannot be interpreted as impulse response functions to monetary policy shocks, since the paths we report are conditional expectations and reflect all the shocks that are the most likely to generate the interest rate paths in the two scenarios, not only the policy shock.

Looking at the monetary aggregates, we find that, as expected, the effect on M1 is large and positive while the effect on M3 is negligible. This supports our point that non-standard measures affected the macroeconomy via their impact on interest rates and spread, rather than via quantity effects through the evolution of broad money.

The results regarding real activity (industrial production and unemployment) show a sizable positive effect of non-standard measures only after a delay of several months. However, the impact effect of the introduction of such measures is negative. These results are consistent with the view that interest rate changes only affect real activity with a lag. The negative effect on impact reflects the positive contemporaneous correlation between interest rates and real activity in the data.

Finally, inflation, as real activity, is only affected positively with a lag while on impact the effect is negative. Moreover, the positive impact at the end of our evaluation sample is relatively subdued indicating that non standard policy measures acting through interest rates are not foreseen to be inflationary. However, as reported by Giannone, et al. (2009), the performance of the VAR model to explain the dynamics of inflation in the last two years is sensibly worse than for all other variables. Hence, particular caution is in order when interpreting our results on inflation.

## 6. CONCLUDING REMARKS

This paper describes the monetary policy response of three central banks to the financial crisis of 2007-08, with a focus on the implementation of so-called non-standard measures.

We argue that, although there are some differences in how the three institutions responded to the financial crisis, these largely reflect cross-national variations in financial structure. The similarity of the responses more than outweighs these differences. In particular, we believe that all three central banks placed considerable weight on maintaining market functioning following the collapse of Lehman Bros. and thereby focused on containing and narrowing interest rate spreads. We argue that quantitative easing has mainly worked through its effect on interest rates spreads, given the policy rate. For the euro area we have proposed an econometric exercise based on the Giannone, et al. (2009)'s Bayesian VAR which includes real, nominal, and disaggregated credit and monetary variables with the associated interest rates. Our estimates indicate that the effect of the compression of the spreads stemming from the implementation of the ECB's so-called "enhanced credit support" has been

sizeable on both loans and interest rates, very modest on broad money, and has acted on the real economy with a delay. These effects are very much in line with what has been found for the transmission of a standard monetary policy shock in normal times (see Giannone, et al. (2009)). Overall our results suggest that the non-standard measures have played a quantitatively significant role in stabilising the financial sector and economy after the collapse of Lehman Bros., even if insufficient to avoid a significant fall in economic and financial activity.

Our detailed description of non-standard measures during the crisis suggests that, in exceptional times, central banks have instruments other than the policy rate with which they can help to stabilize the financial system and broader economy. This is true whether or not the policy rate is constrained by any lower bound. For example, in the euro area, the ECB's non-standard measures and liquidity management kept the market overnight interest rate below the MRO rate, implying an effective easing of financial conditions without a change in the key policy rate. The Federal Reserve's introduction of remuneration on reserves (as already practiced by the ECB and Bank of England) increases its flexibility to pursue similar measures, since liquidity management can be separated more clearly from changes in the policy rate (the Fed Funds target). Such considerations are likely to play an important role in the exit from non-standard measures. Of course, this increased complexity resulting from the multiplicity of and interrelationship among central bank instruments presents new challenges for central bank communication.

Overall, there is no doubt that central banks' non-standard measures have acted to avoid the financial meltdown that was feared after the collapse of Lehman, even if many challenges and open issues remain regarding the future conduct and interaction among monetary policy, liquidity management and financial regulation and supervision. For the economics profession, this crisis has been a reminder that it is impossible to understand monetary policy without an understanding of financial markets and financial intermediation.

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## APPENDIX

### The Bayesian VAR model of the euro area (Giannone, et al., 2009)

The VAR model of the euro area used in this paper is based on Giannone et al. (2009) and includes 32 monthly variables for the sample January 1991 - August 2009. The model is estimated in log-levels (except for variables already defined as rates), with 13 lags. Definitions and transformations are reported in the table below.

**Table: Data and transformations**

Variables	Transformation
Industrial Production	log-levels
HICP	log-levels
Unemployment rate	Levels
Producer Prices Index	log-levels
US Industrial Production	log-levels
US Consumer Prices Index	log-levels
US Federal Funds Rate	Levels
Euribor 3 months	Levels
Euribor 12 months	Levels
Consumer Confidence	Levels
World price of raw materials	log-levels
Oil price	log-levels
US/Euro exchange rate	log-levels
Stock prices	log-levels
2 years bond rate	Levels
3 years bond rate	Levels
5 years bond rate	Levels
7 years bond rate	Levels
10 years bond rate	Levels
M1	log-levels
M2	log-levels
M3	log-levels
Own rate of return, M1	Levels
Own rate of return, M3	Levels
Loans to non-financial corporations up to one year	log-levels
Loans to non-financial corporations over one year	log-levels
Consumer loans	log-levels
Loans for house purchases	log-levels
Other loans	log-levels
Lending rate to NFC up to one year	Levels
Lending rate, consumer loans	Levels
Lending rate, loans for house purchases	Levels

Estimates of such a large dynamic model by classical methods would be unstable and unreliable due to estimation error. In our framework, we use Bayesian shrinkage, as suggested in De Mol, et al. (2008) and Banbura, et al. (2009). Specifically, we use a Litterman (random walk) prior, with tightness set so that the in-sample fit of the interest rate equation in the 32



variable VAR model is at the level achieved by a simpler eight-variable monetary VAR using only the first eight variables in the table above. This approach is motivated by evidence that short-term interest rates are well-described by linear functions of current and future inflation and real activity (i.e. Taylor-type rules).

