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(Occasional Papers)

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# UNCONVENTIONAL MONETARY POLICY IN THEORY AND IN PRACTICE

by Martina Cecioni\*, Giuseppe Ferrero\* and Alessandro Secchi\*

## Abstract

In this paper, after discussing the theoretical underpinnings of unconventional monetary policy measures, we review the existing empirical evidence on their effectiveness, focusing on those adopted by the European Central Bank and by the Federal Reserve. These measures operate in two ways: through the signalling channel and through the portfolio-balance channel. In the former, the central bank can use communication to steer interest rates and to restore confidence in the financial markets; the latter hinges on the hypothesis of imperfect substitutability of assets and liabilities in the balance sheet of the private sector and postulates that the central bank's asset purchases and liquidity provision lower financial yields and improve funding conditions. The review of the empirical literature suggests that the unconventional measures were effective and that their impact on the economy was sizeable. However, a very large degree of uncertainty surrounds the precise quantification of these effects.

**JEL Codes:** E52, E58.

**Keywords:** Central bank, unconventional monetary policy, financial crisis, signalling channel, portfolio balance channel.

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## 1. Introduction\*

In normal times central banks implement monetary policy by steering official interest rates and explaining to the public how a particular monetary stance in a given economic environment should contribute to achieving the final goals. To this purpose, central banks may decide to share with the public their views about the future evolution of some key macroeconomic variables or even their policy intentions.

Monetary policy decisions and announcements are first transmitted to the interbank market (the market for central bank reserves). When market conditions are quiet, central banks' monopolistic power in the provision of reserves allows them to steer interest rates in the interbank market very accurately.

In such an environment the provision of liquidity to the banking system is a mechanical exercise and liquidity management operations are designed exclusively to implement the desired level of short-term interest rates. In particular, the provision of liquidity does not contain any information about the monetary policy stance beyond that included in the official interest rate.<sup>1</sup> Moreover, during normal times the central bank only cares about injecting the banking system with the appropriate amount of reserves while their distribution among depository institutions takes place endogenously through the interbank market.

The monetary impulse is then transmitted through different channels to all the other financial markets.<sup>2</sup> In particular, it also affects credit market conditions and long-term interest rates, which are key elements in the public's investment-consumption decisions. Through this transmission mechanism the central bank can therefore pursue its final objectives in terms of inflation and possibly growth.

During a financial crisis implementing monetary policy is a much more complex exercise as the transmission mechanism can be severely impaired by disruptions in the financial markets. First of all, the increase in the volatility of the demand for reserves and the limited redistribution of liquidity among depository institutions may adversely affect the central bank's ability to control short-term interest rates in the interbank market. Second, disruptions in other segments of the financial market may hamper the transmission of the monetary impulse across the full spectrum of financial assets. Finally, when the effect of the crisis on the real economy is large, the zero lower bound for interest rates may become a binding constraint for monetary policy decisions.<sup>3</sup> In these situations central banks may need to resort to unconventional measures to regain control on the economy.

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<sup>1</sup> This independence between policy decisions and liquidity provision is called the "separation" or "decoupling" principle (Borio and Disyatat 2010).

<sup>2</sup> Bernanke and Gertler (1995), Mishkin (1996), Blinder, Ehrmann, Fratzscher, de Haan, Jansen (2008) and Boivin, Kiley and Mishkin (2010).

<sup>3</sup> "The zero lower bound on nominal interest rates limits the ability of central banks to reduce short-term interest rates. As a result, when nominal interest rates are near zero, central banks are unable to use further reductions in short-term interest rates to provide additional stimulus to the economy and check unwelcome disinflation", Chung et al. (2011).

There is not a universally accepted definition of a non-standard monetary policy measure: as Borio and Disyatat (2010) observe, the difference between a conventional and an unconventional tool might, in some cases, be very tenuous.<sup>4</sup> In this paper we adopt a very broad characterization and we include in the set of unconventional measures any policy intervention that aims to rectify a malfunctioning of the monetary transmission mechanism or to provide further stimulus to the economy when the official interest rates reach the zero bound. We therefore classify as non-standard tools all the measures implemented during the global financial crisis that addressed liquidity shortages both of depository institutions and of other important segments of the financial market, the direct purchase of private and public securities, and the adoption of particular forms of communication designed to restore a more normal functioning of the markets and influence expectations about future official interest rates.

During the global financial crisis recourse to these measures was heterogeneous across countries. This reflected differences in the structure of the respective financial systems and in the severity of market disruptions, as well as the role of central banks' judgment. During unconventional times this last factor contributes more because of the lack of sound theory and empirical evidence on the effectiveness of non-standard measures (Trichet 2010). To fill this gap, and to equip policy makers with sounder evaluation instruments, the profession has recently devoted considerable effort to improving formal understanding of the mechanisms through which unconventional monetary measures influence the economy and to testing for their empirical relevance. This strand of literature has grown rapidly and is now sufficiently large to allow some conclusions to be drawn.

In this paper, we describe the various measures adopted in the US and in the euro area during the recent crisis, we provide a review of the main theoretical underpinnings that support the use of unconventional measures in the case of financial distress, and we survey the evidence on their effectiveness. While there is no doubt that these measures prevented a collapse of the financial system and a deeper contraction of the real economy as a result of the global crisis, a clearer understanding of the contribution of each, from both a theoretical and an empirical perspective, is a necessary step towards defining an "optimal unconventional tool-box".

In the review of the theoretical literature on the functioning of unconventional measures we identify two channels of transmission.

The first is the *signalling channel*, which enables the central bank to use communication to restore confidence in the markets and influence private expectations about future policy decisions. This channel may be particularly useful when official interest rates reach the zero lower bound and the central bank needs to provide further stimulus to the economy.

The purchase of public and private securities and the provision of credit to financial and non-financial institutions affect the economy through the *portfolio-balance channel*, which operates when assets and liabilities in the balance sheets of the private sector are imperfectly substitutable. The central bank can exploit this channel when it wants to alleviate tensions in particular segments of the financial markets, when it seeks to reduce yields more widely, and when it decides to counteract the impact of financial frictions on funding conditions.

In the review of the empirical evidence on the effectiveness of unconventional measures we focus on the euro area and on the US as the analysis of these two areas allows us to review a broad spectrum of unconventional measures ranging from the bank-oriented decisions adopted

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<sup>4</sup> While the adoption of a new monetary policy tool is certainly an unconventional measure, it is less clear whether more frequent and more intense use of a standard tool can be classified as a conventional or as an unconventional measure, especially when it is used for non-standard purposes.

in the euro area to the more market-oriented actions implemented on the other side of the Atlantic.

The choice of a classification scheme for unconventional measures displays the same degree of arbitrariness as the division of monetary measures into conventional and unconventional. This is reflected in the abundance of taxonomies currently available in the literature.<sup>5</sup> In this paper we classify the available empirical studies according to whether they examine the impact of non-traditional tools (i) on financial variables or (ii) on macroeconomic variables, and according to the methodology followed in the empirical investigation.

All in all, this review suggests that the unconventional measures adopted on both sides of the Atlantic were so far effective in influencing financial and macroeconomic variables. However, considerable uncertainty surrounds the quantification of these effects. Moreover, an important issue, only mentioned at the end of the paper, concerns the potential costs to central banks of reversing such measures and their possible impact on private banks' risk-taking behaviour (moral hazard).<sup>6</sup>

The paper is organized as follows. Section 2 provides a brief chronological description of the unconventional measures adopted in the US and in the euro area up to mid-2011. Section 3 analyses the theoretical support for their effectiveness. Section 4 surveys the empirical evidence and Section 5 concludes.

## **2. Description of central banks' interventions during the financial crisis**

In this section we present the unconventional tools adopted by the Fed and the ECB during the global financial crisis, up to mid-2011.<sup>7</sup> We provide two types of complementary information. In the text we mostly focus on the rationale behind each specific measure, on the description of the particular market conditions that led to its adoption, and on how each of these measures was expected to restore a more normal functioning of the monetary transmission mechanism and/or to provide further stimulus to the economy. In addition, in Tables 1 and 2 we describe in detail the main characteristics of each unconventional tool adopted, respectively, by the Fed and the ECB (inception and duration of the programme, maximum and average impact on the central bank's balance sheet, eligible counterparties, collateral, etc.). We first describe the measures adopted at the beginning of the crisis (August 2007 – September 2008) and then the actions taken in the most acute phase, following the collapse of Lehman Brothers in September 2008.

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<sup>5</sup> Stone, Fujita and Ishi (2011), for example, suggest a classification based on whether the final objective of the unconventional operation is one of financial or macroeconomic stability; Borio and Disyatat (2011) propose a taxonomy based on the particular financial market targeted by the unconventional operations and on their impact on the private sector's balance sheets; Bini Smaghi (2009) classifies unconventional measures into "endogenous credit easing" – measures designed to provide abundant liquidity to commercial banks – "credit easing" – measures to address liquidity shortages and counter spreads in other dysfunctional segments of the financial market – and "quantitative easing" – purchases of government bonds to reduce long-term risk-free rates; Bernanke (2009) adopts a similar taxonomy.

<sup>6</sup> Some remarks on the challenges and risks of reversing unconventional monetary policy are discussed in Buiter (2010) and Borio and Disyatat (2010).

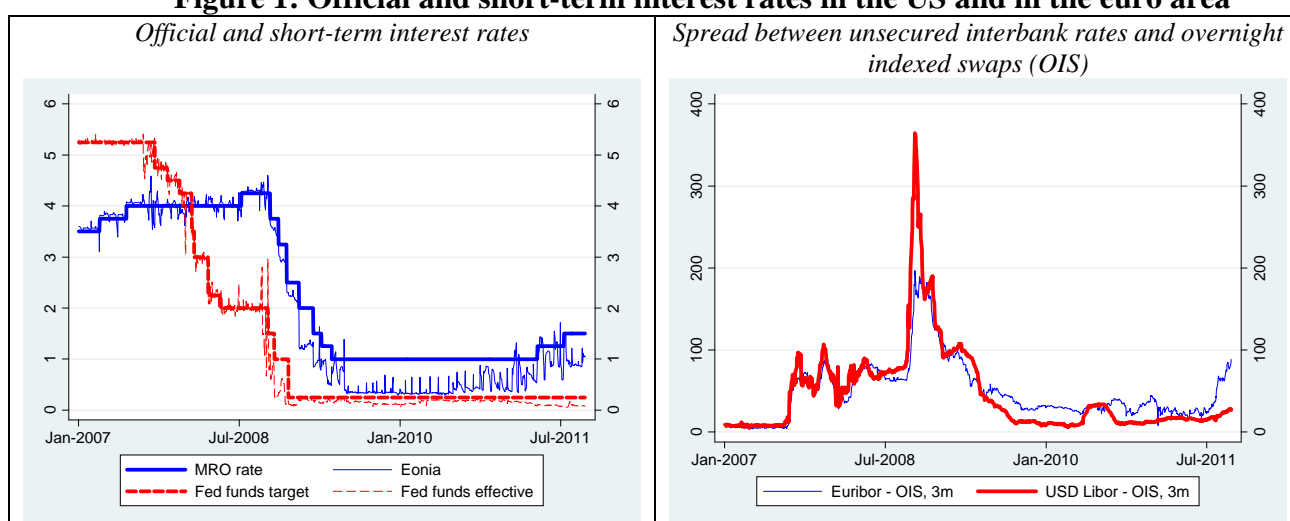
<sup>7</sup> We do not consider here other important economies. Stone, Fujita and Ishi (2011) provide an exhaustive description of the main unconventional monetary measures adopted both in advanced and in emerging countries.

Measures adopted by the Fed in the pre-Lehman phase (August 2007-September 2008)

The first phase of the crisis featured a significantly higher volatility of banks' liquidity demand, a heightened preference for long-term liquidity and severe impairments in the redistribution of funds in the interbank market. During this period the unconventional measures adopted by the Fed and the ECB aimed to prevent disorders in money markets hampering the monetary transmission mechanism, but both central banks sterilized the impact of their actions on the monetary base in order to keep overnight interest rates in line with their targets (Figure 1).

In the US, where reserves are normally channelled to the banking system through a small group of primary dealers, the Fed implemented a series of measures to extend the availability of emergency and long-term funding to both these intermediaries and depository institutions.<sup>8</sup>

**Figure 1: Official and short-term interest rates in the US and in the euro area**



With the adoption of the *Term Discount Window Program* (TDWP; Table 1, column 1) the Fed progressively extended the maximum maturity of emergency loans available to depository institutions through the Discount Window and diminished the discount rate premium charged on this facility. The *Term Auction Facility* (TAF; Table 1, column 2) pursued a similar objective by providing collateralized long-term liquidity to depository institutions and supporting the redistribution of funds in the interbank market.<sup>9</sup> However, under the TAF the Fed auctioned term funds to banks to minimize the risk that depository institutions could be discouraged from requesting funds because of “stigma” issues. While use of the TDWP was generally limited, possibly owing to the associated perceived stigma, the TAF turned out to be an important channel of liquidity provision (Figure 2). Recourse to it reached a peak of around \$500 billion after the collapse of Lehman Brothers.

<sup>8</sup> The Fed manages its balance sheet so as to maintain the permanent liquidity deficit of the banking system very low and satisfies it, so to keep the effective fed fund rate in line with its target, through short term repo operations implemented with a small group of primary dealers. In the US this operational framework was considered to be more efficient than one based on a direct relation between the central bank and each depository institution. In normal times primary dealers do not have access to emergency funding.

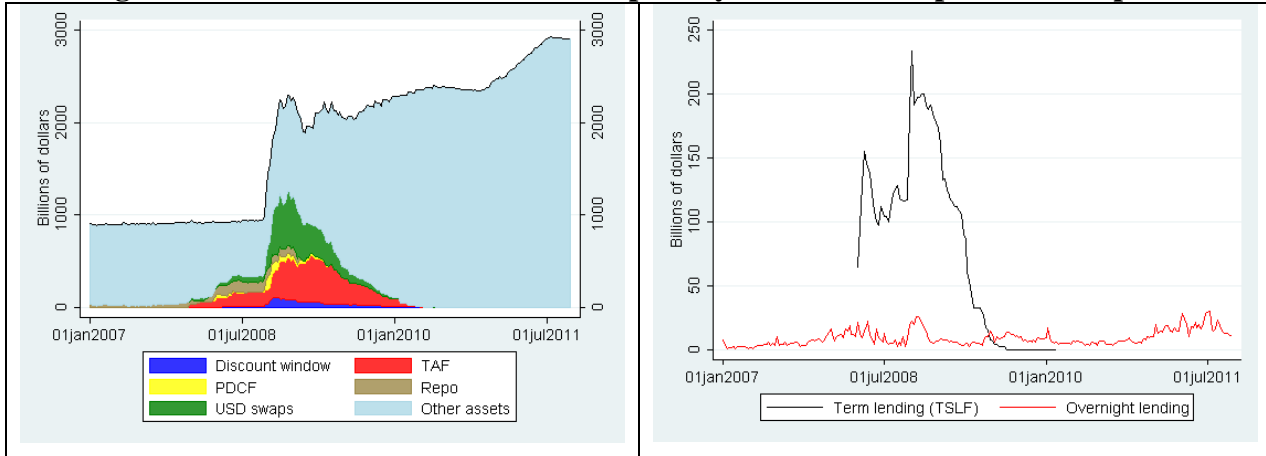
<sup>9</sup> The collateral that is eligible in the TAF programme is the same as in the Discount Window Facility.

**Table 1: Unconventional measures adopted by the Federal Reserve (August 2007 – September 2011)**

	1	2	3	4	5	6	7	8	9	10	11
	<b>Term Discount Window Program (TDWP)</b>	<b>Term Auction Facility (TAF)</b>	<b>Reciprocal Currency Agreements (RCA)</b>	<b>Term Securities Lending Facility (TSLF)</b>	<b>Single-Tranche OMO programme</b>	<b>Primary Dealers Credit Facility (PDCF)</b>	<b>ABCP Money Market Fund Liquidity Facility (AMLF)</b>	<b>Commercial Paper Funding Facility (CPFF)</b>	<b>Term Asset-Backed Securities Loan Facility (TALF)</b>	<b>Purchase of Agency Debt and Agency MBS</b>	<b>Purchases of long-term Treasuries</b>
<i>Announcement date</i>	Aug. 17, 2007	Dec. 12, 2007	Dec. 12, 2007	Mar. 11, 2008	Mar. 11, 2008	Mar. 16, 2008	Sept. 19, 2008	Oct. 7, 2008	Nov. 25, 2008	Nov. 25, 2008	Mar. 18, 2009
<i>Start date</i>	Aug. 17, 2007	Dec. 17, 2007	-	Mar. 27, 2008	Mar. 27, 2008	Mar. 17, 2008	Sept. 22, 2008	Oct. 27, 2008	Mar. 17, 2009	Jan. 5, 2009	Mar. 25, 2009
<i>End date</i>	Mar. 18, 2010 <sup>(2)</sup>	Mar. 8, 2010	-	Feb. 1, 2010	Dec. 30, 2008	Feb. 1, 2010	Feb. 1, 2010	Feb. 1, 2010	Jun. 30, 2010 <sup>(4)</sup>	Mar. 31, 2010	Jun. 30, 2011 <sup>(5)</sup>
<i>Participants</i>	Depository institutions	Depository institutions	Foreign central banks	Primary dealers	Primary dealers	Primary dealers	Depository institutions, bank holding companies (domestic and international)	Eligible CP issuers	All US persons that owns eligible collateral	-	-
<i>What are they borrowing?</i>	Funds	Funds	US dollars	US Treasuries	Funds	Funds	Funds	Funds	Funds	-	-
<i>Collateral</i>	Full range of Discount Window Collateral	Full range of Discount Window Collateral	Central banks pledge foreign currency and lend against collateral in their jurisdictions	US Treasuries, agencies, MBS and all investment grade debt securities	US Treasuries, agencies, MBS, but typically agencies MBS	Full range of tri-party repo system collateral	First-tier ABCP	Newly-issued 3-month unsecured and asset-backed CP from eligible US issuers	Recently originated US dollar-denominated AAA, ABS, CMBS and legacy CMBS	-	-
<i>Term of the loan</i>	up to 90 days	28 or 84 days	up to 3-month	28 days	28 days	Overnight	ABCP maturity date (max 270-day)	3 months	3 or 5 years	Outright purchases	Outright purchases
<i>Frequency</i>	Standing facility	Every other week, or as necessary (auction)	-	Every four weeks (auction)	Every week (auction)	Standing facility	Standing facility	Standing facility	Twice a month, alternating ABS and CMBS	-	-
<i>Average impact on Fed balance sheet<sup>(1)</sup></i>	\$29 bn <sup>(3)</sup>	\$206 bn	\$90 bn	\$80 bn	approx \$80 bn.	\$19 bn	\$21 bn	\$147 bn	\$36 bn	\$107 bn (Agency debt), \$575 bn (Agency MBS)	\$471 bn <sup>(6)</sup>
<i>Max impact on Fed balance sheet<sup>(1)</sup></i>	\$112 bn <sup>(3)</sup>	\$493 bn	\$583 bn	\$234 bn	\$80 bn	\$148 bn	\$146 bn	\$350 bn	\$48 bn	\$169 bn (Agency debt), \$1074 bn (Agency MBS)	\$1182 bn <sup>(6)</sup>
<i>Objective</i>	Provide liquidity to depository institutions	Provide liquidity to depository institutions	Provide liquidity in US dollars to foreign banks	Provide Treasuries to primary dealers	Provide liquidity to primary dealers	Provide liquidity to primary dealers	Restore liquidity in the ABCP market	Enhance the liquidity of the commercial paper market	Support lending to small businesses and consumers	Reduce costs and increase availability of credit for housing	Reduce term premia in the long-term interest rates

Sources: *Forms of Federal Reserve Lending*, Federal Reserve New York; *Credit and Liquidity Programs and the Balance Sheet*, Board of Governors; *Federal Reserve statistical release, H.4.1, Factors affecting reserve balances*, Tables 1-8, Board of Governors. Notes: (1) Descriptive statistics computed on weekly averages over the life of the programme. (2) On February 18, 2010, the Federal Reserve announced that the typical maximum maturity on primary credit would be shortened to overnight, effective March 18, 2010. (3) Statistics computed on total primary credit. (4) On that date the facility was closed for new loan extensions against newly issued commercial mortgage-backed securities. (5) On September, 21th, 2011 the FOMC has announced the intention to purchase, by the end of June 2012, \$400 billion of Treasury securities with maturity between 6 and 30 years and to sell an equal amount of Treasury securities with maturities of 3 years or less. (6) Purchases of US Treasury securities since March 25, 2009. Starting from August 11, 2010 it includes Treasuries purchases from the reinvestment of principal payments on Agency debt and Agency MBS. On September, 21th, 2011 the FOMC has announced the intention to reinvest principal payments from its holdings of agency debt and agency mortgage-backed securities in agency mortgage-backed securities.

**Figure 2: Unconventional measures adopted by the Fed in the pre-Lehman phase**



In order to satisfy the exceptional needs for US dollar funding by foreign banks the Fed provided dollars to foreign central banks by means of temporary *Reciprocal Currency Agreements* (RCA; Table 1, column 3). These central banks, in turn, offered US dollar liquidity to their respective banking systems. Moreover, to alleviate pressures in the secured funding market the Fed also started the *Term Securities Lending Facility* (TSLF; Table 1, column 4) with which it lent US Treasuries to primary dealers against a wide range of less liquid securities.<sup>10</sup> Finally, with the *Single-Tranche OMO Program* (Table 1, column 5) and with the *Primary Dealers Credit Facility* (PDCF; Table 1, column 6) the Fed provided, respectively, emergency and long-term liquidity to primary dealers.<sup>11</sup>

*Measures adopted by the ECB in the pre-Lehman phase (August 2007 – September 2008)*

The ECB also implemented exceptional measures to fight back against the initial effects of the crisis. However, unlike the Fed, it was able to counteract shocks to the distribution of reserves in the banking system within its standard operational framework. This was due to two reasons: first, the ECB manages its balance sheet so as to keep a large permanent liquidity deficit;<sup>12</sup> second, all depository institutions of the euro area have direct access to central bank's liquidity.<sup>13</sup>

The ECB accommodated banks' heightened preference for long-term funding straightforwardly by increasing the frequency and the liquidity allotted in its long-term refinancing operations (Figure 3).<sup>14</sup> Moreover, to counteract the excessive volatility of the overnight rate (Eonia) within the maintenance period, it satisfied banks' preference for early fulfilment of the reserve requirements (front-loading) by providing a relatively larger volume of funds in the first part of the maintenance period. Finally, the increased volatility in liquidity demand and the larger demand for US dollars were offset, respectively, by greater recourse to *fine-tuning operations* (Table 2, column 1) and through auctions of US dollar liquidity, available from the Fed *Reciprocal Currency Agreements* (Table 2, column 2).

<sup>10</sup> The Fed offers securities for loan from the SOMA portfolio also in normal times. This "standard" securities lending programme is collateralized with Treasuries and is conducted on an overnight basis.

<sup>11</sup> The PDCF was intended to be a backstop facility. The credit extended through this facility was charged with a penalty rate and subject to a frequency-based fee after 45 days of use.

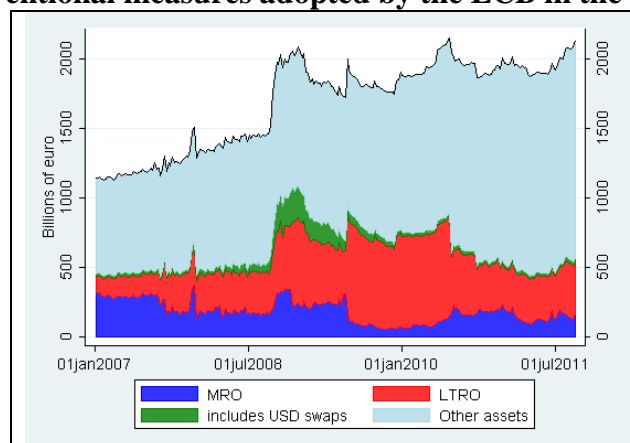
<sup>12</sup> The ECB satisfies this liquidity deficit through main and long-term refinancing operations. These operations are collateralized loans with maturities of one week and three months. Before the crisis the relative weight of these two operations was approximately two thirds and one third.

<sup>13</sup> Currently, about 2200 credit institutions have access to the Eurosystem refinancing operations.

<sup>14</sup> The impact of the more abundant provision of long-term funding on the total amount of reserves provided to the banking system was offset by a reduced supply of reserves in the main refinancing operations.

The adoption of these measures was supplemented by a significant effort of communication aimed at maintaining a clear separation between monetary policy decisions and liquidity provision operations (the “separation principle”). To counteract the renewed volatility of the Eonia and the increase in money market spreads that followed the collapse of Bear Stearns in March 2008, the ECB introduced *supplementary long-term operations* (Table 2, column 3) with a maturity of six months.

**Figure 3: Unconventional measures adopted by the ECB in the pre-Lehman phase**



Measures adopted by the Fed in the post-Lehman phase (September 2008- onward)

After the bankruptcy of Lehman Brothers in September 2008 the financial crisis became more severe and spread to the shadow banking system. In the US it quickly became clear that the provision of funds and high-quality securities to depository institutions and primary dealers would not be sufficient to avert a collapse of the financial system. The liquidity in critical non-bank markets evaporated and financial spreads reached unprecedented levels. To address these issues the Fed enhanced the non-standard measures adopted before Lehman’s bankruptcy and implemented a series of new unconventional tools.

To understand the crucial role of this new set of measures it is useful to start with a stylized description of the functioning of the US financial system on the eve of the financial crisis. Under a standard banking system, banks generate loans using deposits or longer-term liabilities and hold them to maturity in their balance sheets. Given their crucial role in the economy, these institutions have direct access to central bank liquidity, enjoy government guarantees, but are also subject to a strict regulation that limits their balance-sheet exposure to credit and liquidity risks.

In the years before the outbreak of the financial crisis, the credit provision function was progressively moved into an unregulated shadow banking system where financial institutions made large profits by increasing the leverage of their business well above the limits permitted in the traditional system.<sup>15</sup> This alternative banking system is populated by a very heterogeneous group of financial institutions that are strictly interconnected and that conduct maturity, credit and liquidity transformation through a wide range of secured funding techniques such as asset-backed commercial papers (ABCP), asset-backed securities (ABS), collateralized debt obligations (CDO) and repos.<sup>16</sup>

<sup>15</sup> See Gorton (2010) and Pozsar et al. (2010).

<sup>16</sup> The shadow banking system includes special investment vehicles (SIVs), special purpose vehicles (SPVs), money market funds, hedge funds, monolines, investment banks, and many other non-bank financial institutions.

**Table 2: Unconventional measures adopted by the ECB (August 2007 – September 2011)**

	1	2	3	4	5	6	7	8
	<b>Fine-tuning operations</b>	<b>Reciprocal currency agreements</b>	<b>Long-term 6-month operations</b>	<b>Special term refinancing operations</b>	<b>Fixed-rate and full allotment on refinancing operations</b>	<b>Long-term 12-month operations</b>	<b>Covered Bond Purchase Programme (CBPP)</b>	<b>Securities Markets Programme (SMP)</b>
<i>Announcement date</i>	Quick tender	Dec. 12, 2007	Mar. 27, 2008	Sep. 29 2008	Oct. 9-15, 2008	May 7, 2009	May 7, 2009	May 9, 2010
<i>Start date</i>	Facility already existing in the ECB operational framework	Dec. 17, 2007	Mar. 28, 2008	Sept. 30, 2008	Oct. 15, 2008	Jun. 24, 2009	Jun. 4, 2009	May 14, 2010
<i>End date</i>	-	Ongoing	May 12, 2010 <sup>(3)(4)</sup>	Ongoing	Ongoing	Dec. 16, 2009 <sup>(3)</sup>	Jun. 30, 2010	Ongoing
<i>Participants</i>	All banks that have access to Eurosystem credit operations	All banks that have access to Eurosystem credit operations	All banks that have access to Eurosystem credit operations	All banks that have access to Eurosystem credit operations	All banks that have access to Eurosystem credit operations	All banks that have access to Eurosystem credit operations	All banks that have access to Eurosystem credit operations and euro-area based counterparties used by the Eurosystem for the investment of its euro-denominated portfolios	All banks that have access to Eurosystem credit operations and euro-area based counterparties used by the Eurosystem for the investment of its euro-denominated portfolios
<i>What are they borrowing?</i>	Funds	Funds in US dollars, Swiss francs and pound sterling	Funds	Funds	Funds	Funds	-	-
<i>Collateral</i>	Collateral eligible for Eurosystem credit operations	Collateral eligible for Eurosystem credit operations	Collateral eligible for Eurosystem credit operations	Collateral eligible for Eurosystem credit operations	Collateral eligible for Eurosystem credit operations (expanded as of decision of 15 Oct. 2008)	Collateral eligible for Eurosystem credit operations (expanded as of decision of 15 Oct. 2008)	-	-
<i>Term of the loan</i>	From overnight to 5 days	7, 28, 35 and 84 days	6 months	Same as the length of the maintenance period for the banks' reserve requirement	1 week, 1, 3, 6 and 12 months	1 year	Outright purchases in the primary and secondary markets	Outright purchases in the secondary market
<i>Frequency of the program</i>	As necessary (auction)	In connection with the US \$ TAF at the Federal Reserve	As necessary (auction)	Once at the beginning of each maintenance period	-	3 auctions in 2009 (June, September, December)	-	-
<i>Average impact on the Eurosystem's consolidated balance sheet <sup>(1)</sup></i>	-	€62 bn <sup>(2)</sup>	€66 bn <sup>(4)</sup>	€58 bn	-	€417 bn	€31 bn	€71 bn
<i>Max impact on the Eurosystem's consolidated balance sheet <sup>(1)</sup></i>	-	€249 bn <sup>(2)</sup>	€155 bn <sup>(4)</sup>	€135 bn	-	€614 bn	€61 bn	€157 bn
<i>Objective</i>	Assure orderly conditions in the euro money market	Assure liquidity in foreign currencies to euro-area banks	Support the normalisation of the functioning of the euro money market.	Improve the overall liquidity position of the euro-area banking system	Assure the provision of liquidity to all euro-area banks	Encourage the provision of credit by banks to the private sector	Restore the covered bonds market segment	Address the malfunctioning of securities markets and restore the monetary transmission mechanism

Sources: ECB *Weekly Financial Statements*; ECB Statistical Data Warehouse *Eurosystem consolidated balance sheet*.

Notes: (1) Descriptive statistics computed on weekly averages over the life of the programme. (2) Data from the balance-sheet item *Claims on euro area residents denominated in foreign currency* which includes US swaps.

(3) Date at which the last operations has been conducted. (4) A 6-month operation was reactivated on August, 10<sup>th</sup>, 2011. Descriptive statistics presented in the table do not take into account the impact of this operation on Eurosystem's balance sheet.

The fundamental weakness of this system, which had neither deposit guarantees nor direct access to central bank liquidity, and its exposure to the same type of bank runs that devastated the traditional banking system during the Great Depression, became apparent when in September 2008 the net asset value of some important money market funds fell below the target value of one dollar per share and these funds received massive requests for redemptions.<sup>17</sup> The strict interconnections among the different segments of the shadow banking system accelerated the transmission of the crisis and quickly affected the prices and the liquidity of other important instruments of this market (ABCP, ABS, CDO, etc). The existence of liquidity provision agreements between the institutions of the traditional and the shadow banking system suddenly also exposed the former to a strong liquidity shortage. In essence, the entire financial system of the US came very close to collapse.

With the unconventional measures adopted since mid-September 2008 the Fed has greatly extended the provision of temporary liquidity to the most important part of the shadow banking system. This was done (mainly) through three programmes.

With the *ABCP Money Market Fund Liquidity Facility* (AMLF; Table 1, column 7) the Fed provided short-term loans to depository institutions to finance purchases of high-quality ABCP from money market mutual funds, thus sustaining their prices by avoiding fire sales. A similar objective was pursued with the *Commercial Paper Funding Facility* (CPFF; Table 1, column 8), which provided a temporary liquidity backstop to issuers of commercial paper and was intended, in particular, to reduce investors' and borrowers' concerns about "roll-over risk" (Figure 4, left panel).

In contrast, the objective of the *Term Asset-Backed Securities Loan Facility* (TALF; Table 1, column 9) was to substitute public for private balance-sheet capacity in a period in which there were serious risks of a credit crunch owing to sharp deleveraging and high risk aversion. With this programme the Fed provided investors with long-term loans (3 to 5 years) for the purchase of newly issued triple-A rated ABS backed by consumer and small business loans. The facility was subsequently expanded to include newly issued highly rated commercial mortgage-backed securities (CMBS).

Observing the widening of the spreads on GSE debt and on GSE-guaranteed mortgages, in November 2008 the Fed announced a *programme of asset purchases of up to \$100 billion in Agency debt and up to \$500 billion in Agency MBS* (Table 1, column 10) to support the functioning of credit markets for housing. This decision aimed to reduce the cost and increase the availability of credit for house purchases. This, in turn, was expected to support the housing markets and improve conditions in the financial markets more generally.

In the first part of 2009, faced with a further weakening of the economy and a still gloomy outlook for the housing and mortgage markets, the Fed expanded its asset purchase programme, increasing the target of purchases of Agency debt and Agency MBS to \$200 billion and \$1.25 trillion respectively.

Moreover, to improve conditions in private credit markets, it also announced the intention to *purchase up to \$300 billion of long-term Treasury securities* (the so-called QE1; Table 1, column 11) over the following six months.<sup>18</sup> To support the economic recovery, in August 2010, the Fed decided to keep its total holdings of securities constant by reinvesting principal payments from Agency debt and MBS in long-term Treasury securities and to roll over

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<sup>17</sup> A Money market fund investor typically expects to get back one dollar for every dollar invested, plus any interest or dividend earned by the fund.

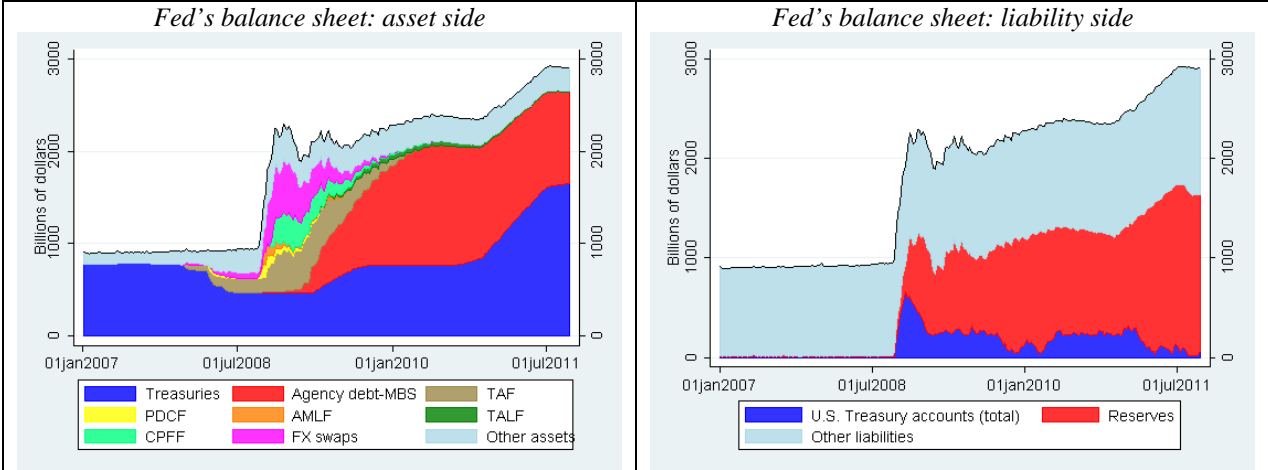
<sup>18</sup> Sometimes QE1 is used also to refer to the purchase programme of MBS and agency debt that was expanded in March 2009 at the same time as the start of purchases of long-term Treasuries was announced. Throughout, we make a distinction between types of assets purchased according to the main objectives of the purchases.

the holdings of Treasury securities as they matured. Faced with the slow recovery of output and employment, on November 2010 the Fed announced a further expansion of its balance sheet by purchasing a further \$600 billion of long-term Treasury securities (the QE2).

These large-scale asset purchase programmes were adopted mainly at the point in which the federal funds rate had effectively reached the zero lower bound. In fact, in December 2008 the Fed lowered its official rate to a range between 0 and 0.25 per cent. Since then, the Fed has been providing forward guidance about the likely path of the Federal funds rate.<sup>19</sup> The Federal Open Market Committee meeting statement noted that “economic conditions are likely to warrant an exceptionally low level of the federal funds rate for some times”. Since March 2009 the expression “for some time” has been replaced with “for an extended period” and in August 2011 it has announced that “economic conditions - including low rates of resource utilization and a subdued outlook for inflation over the medium run - are likely to warrant exceptionally low levels for the federal funds rate at least through mid-2013”.

The new set of unconventional measures adopted after the collapse of Lehman and the extension of those introduced in the first phase of the crisis caused a sharp increase in the size of the Fed’s balance sheet, which soared from around \$1 trillion at the beginning of September 2008 to more than \$2 trillion by the end of the same year. In the same period the reserve balances of depository institutions increased from around \$10 billion to more than \$800 billion (Figure 4, right panel). This sharp increase in reserves pushed the effective federal funds rate well below its target (Figure 1).

**Figure 4: Main unconventional measures adopted by the Fed**



*Measures adopted by the ECB in the post-Lehman phase (September 2008 - onward)*

With the deepening of the financial crisis after the collapse of Lehman Brothers, the interventions of the ECB also became bolder. Official rates were cut by 325 basis points between October 2008 and May 2009, to the historically low level of 1 per cent (Figure 1). At the same time, unconventional measures increased in size and scope, while continuing to operate mainly through the banking sector.

In October 2008, the ECB decided to conduct all its *refinancing operations with fixed rate tenders and full allotment* (FRFA; Table 2, column 5). Those procedures made the provision of liquidity to the banks unlimited (the availability of collateral being the only constraint) and led to a considerable increase in the central bank’s balance sheet (Figure 3). The

<sup>19</sup> It is arguable whether communication of the likely future path of interest rates is a truly unconventional measure of monetary policy given that some central banks have adopted this communication strategy in normal times. Notwithstanding, we include it because it has been one of the Fed’s monetary policy responses to the exceptional circumstances of the US economy and to the zero lower bound on short-term rates.

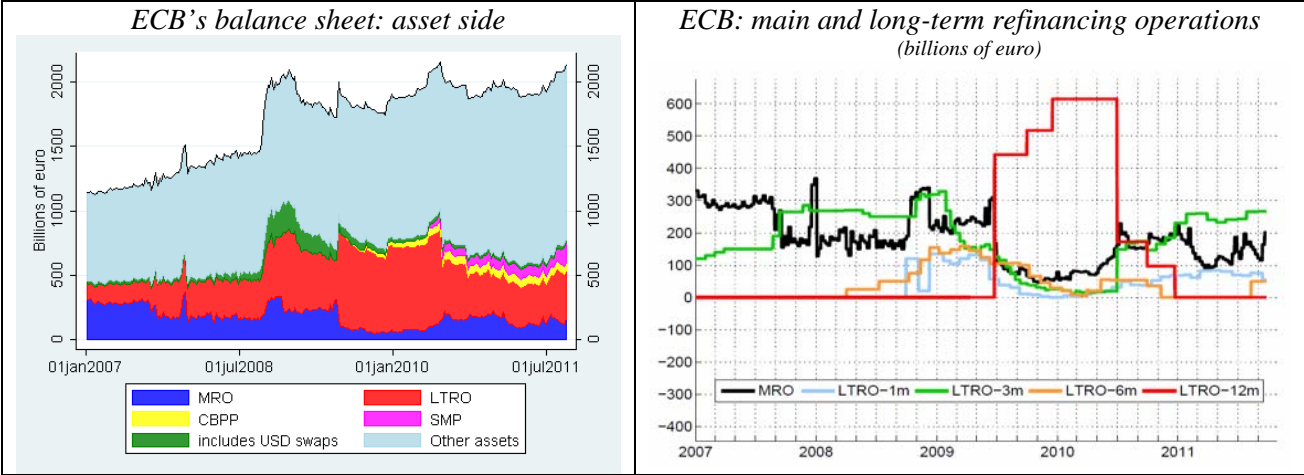
main objectives were to support the availability of credit to firms and households and to counteract the severe disruptions in the interbank market. To guarantee full access to the refinancing operations and to prevent fire sales of assets of lower quality, which would have accelerated the process of further deleveraging in the banks' balance sheets, the ECB also decided to enlarge the set of assets accepted as eligible collateral in its refinancing operations.

In addition, the ECB continued to provide liquidity in US dollars. In the weeks following the collapse of Lehman the contribution of these currency swaps rose to over 10 per cent of the size of the Eurosystem's consolidated balance sheet (around €250 billion; Figure 5, left panel).

The length of the refinancing operations was further increased in May 2009, when the ECB announced three *1-year FRFA refinancing operations* (Table 2; column 6) to be held in June, September and December of the same year. The longer maturity of these operations was expected to restore the monetary transmission mechanism encouraging banks to provide credit to households and firms. In the first of these operations banks demanded an exceptional amount of liquidity (€42 billion; Figure 5, left panel). This implied a drop in the Eonia to levels close to the rate on the deposit facility (0.25 per cent; Figure 1) that was transmitted to all other money market rates.

In May 2009 the ECB also decided to carry out a *Covered Bonds Purchase Programme* (CBPP; Table 2, column 7) to complement the liquidity management measures described above. The programme implied outright purchases, conducted in both the primary and the secondary market, of €60 billion of covered bonds issued by banks in the euro area, to be completed by June 2010. The aim of the CBPP was to revive this market segment, which had been particularly hard hit by the financial turbulence and had been one of the major sources of funds for banks before the crisis.

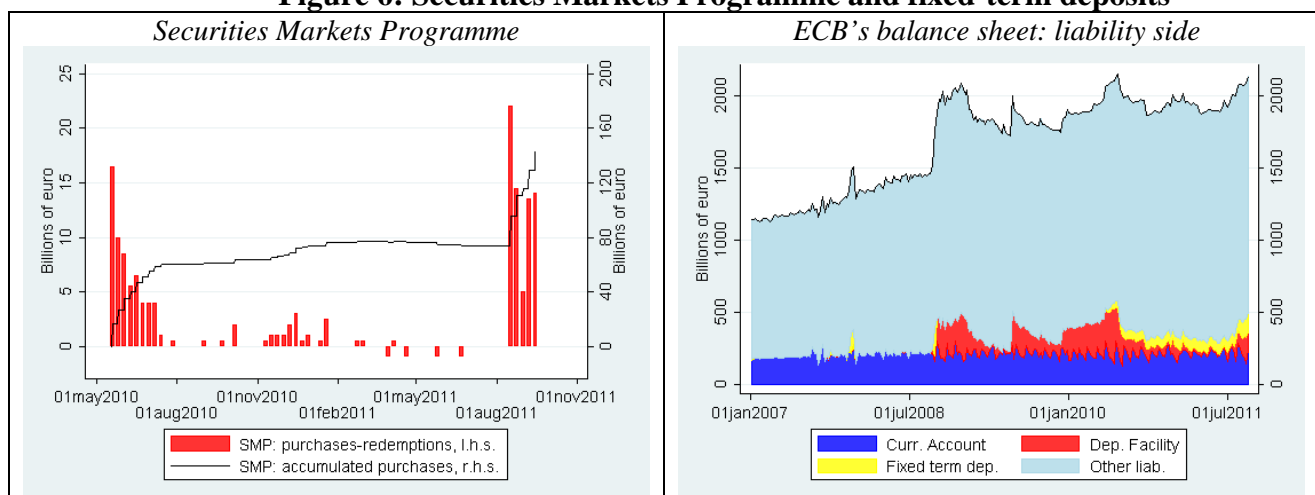
**Figure 5: Main unconventional measures adopted by the ECB**



The financial crisis of 2007 had a considerable and persistent effect on public deficits. In the spring of 2010 the sustainability of the public finance of some euro area countries caught the attention of investors. The functioning of several segments of the financial markets and, in particular, of some government bond markets became seriously impaired. To address this problem and contrast potential spillovers to other sovereign issuers the Governing Council of the ECB decided to implement a program of purchase of euro area private and public securities (*Securities Markets Programme*, SMP; Table 2, column 8), focused on those market segments that were particularly dysfunctional. The objective of this unconventional measure was to support an appropriate functioning of the monetary transmission mechanism. The purchases were heavy during the first phase of the programme and at the beginning of 2011. From February to July 2011 interventions have been very limited. On 7 August 2011 the Governing

Council announced that it would again begin actively implementing the SMP. The decision was taken in view of the increased risk of some government debt markets becoming dysfunctional and tensions spreading to other markets in the absence of intervention (ECB (2011); Figure 6, left panel). Since then, substantial interventions were performed. This unconventional measure does not affect the monetary stance, since the ECB has been sterilizing its impact on the amount of outstanding liquidity through weekly fixed-term deposit operations (Figure 6, right panel).

**Figure 6: Securities Markets Programme and fixed-term deposits**



### 3. Unconventional monetary policy in theory

In this section we describe two channels through which the unconventional monetary policy is transmitted to the economy: the signalling and the portfolio-balance channel.

#### 3.1 The signalling channel

The signalling channel is activated through central bank’s communications informing the public about its intentions regarding the future evolution of short-term interest rates, the purchase of financial assets, or the implementation of other measures targeted at counteracting market dysfunctions. The efficacy of this channel relies on the credibility of the central bank and on the extent to which private expectations and confidence affect macroeconomic and financial market conditions.

Not all forms of communication that exploit the signalling channel should be seen as “unconventional” measures. Since the 1990s it has become increasingly clear that managing expectations is a crucial task of monetary policy; therefore, communication aimed at sharing with the public central bank views about the macroeconomic outlook and, in some cases, about the future evolution of short-term interest rates has evolved into a standard tool of monetary policy.<sup>20</sup> Thus, communication should be considered an unconventional tool of monetary policy only when it is used by a central bank to convey information or pursue objectives that go beyond its standard practice.<sup>21</sup>

In the literature the signalling channel has been highlighted as the mechanism to escape the zero lower bound on official interest rates. Krugman (1998) claims that when the zero lower

<sup>20</sup> An exhaustive analysis of the role of communication in monetary policy is provided by Blinder, Ehrmann, Fratzcher, de Haan and Jansen (2008); Ferrero and Secchi (2009 and 2010) analyse the effects and the desirability of communication of the future interest rate path in “normal” times.

<sup>21</sup> Note that according to this definition certain types of communication can be conventional for some central banks and unconventional for others. This is certainly the case with the announcement of future policy intentions, which is an unconventional tool for most central banks but a conventional measure for central banks such as the Reserve Bank of New Zealand, the Norges Bank and the Swedish Riksbank.

bound binds, the central bank should follow an “irresponsibility principle”, that is, convince the market that it will allow prices to raise so to increase inflationary expectations. Eggertsson and Woodford (2003) embed this result in the New Keynesian (NK) framework concluding that not only is the signalling channel (or, as they call it, the management of expectations) crucial, but it is the only channel that is effective. In the NK model long-term interest rates, on which firms’ and households’ consumption, investment and borrowing decisions are based, depend entirely on financial market participants’ expectations about the future path of short-term rates.

As mentioned, during the financial crisis the Fed provided forward guidance about the likely path of the federal funds rate to promote economic recovery and price stability (see Section 2). However, the central banks did not explicitly commit to the irresponsibility principle advocated by Krugman (1998) and announced that the future official interest rate path would depend on the evolution of the macroeconomic outlook.<sup>22</sup> Clarida (2010) argues that this type of commitment, if not properly qualified, may in practice be confused by the public with a policy of discretion (“policy rates are expected to be low because and so long as output and inflation are expected to be low”) which in case of perfect information is not expected to exert any influence on long-term interest rates. On the contrary, Walsh (2008) shows that, when the central bank is endowed with superior information, the provision of forward guidance about future interest rates is welfare-improving even when monetary policy is discretionary.

Time inconsistency may severely limit the effectiveness of the announcement of an interest rate path: a change in the size and composition of its balance sheet may help to overcome this obstacle. For instance, large purchases of long-term securities may strengthen the promise to keep short-term rates low for some time owing to the adverse effect that an increase in official interest rates would have on the health of the central bank’s balance sheet (Bernanke, Reinhart and Sack 2004). The central bank could also enforce its commitment about future official interest rates by entering into more explicit contingent contracts with market participants. Tinsley (1998), for example, suggests that by selling short-horizon bond put options, the credibility of the central bank’s policy would be enforced by binding contractual arrangements with private sector agents, who will be compensated for any future deviations from the policy terms designated in the contingent contracts.

The practical relevance of these mechanisms is questioned by Rudebusch (2011) who estimates that, notwithstanding its large bond purchases, the Fed’s losses due to an increase in short-term interest rates would be almost negligible. Moreover, these losses would only be realized on the share of the portfolio of long-term securities that is not held to maturity. These estimates and the fact that the central bank is not a private institution with profitability as its main objective suggest that the effectiveness of such a device in preventing short-term rate increases by the central bank is arguable.

Communication aimed at reassuring markets on the central bank’s active role during episodes of financial turbulence can also help to restore the functioning of the monetary transmission mechanism. For example, the announcement of the intention to intervene in illiquid markets provides a signal to market participants that the central bank stands ready to contrast undue volatility in asset prices and provide liquidity in case of necessity. By assuring markets about the central bank’s role of lender of last resort and by providing an implicit guarantee of the intermediation role of the central bank, the announcement itself may influence market behaviour even before any action is taken.<sup>23</sup> The information released concerning the size, the

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<sup>22</sup> “The [Federal Open Market] Committee’s forward guidance has been framed not as an unconditional commitment to a specific federal funds rate path, but rather as an expectation that is explicitly contingent on economic conditions” Yellen (2011).

<sup>23</sup> Although it should be take into consideration that such an announcement may increase moral hazard and therefore contribute to risk-taking behaviour.

speed and, more in general, the terms of the intervention is crucial for the effectiveness of the signalling channel. The central bank's optimal degree of transparency must trade off the credibility and effectiveness potentially gained with a very clear and transparent plan against the risks of providing inappropriate incentives to the market participants and of higher volatility due to not coming up to market expectations.

### 3.2 The portfolio-balance channel

The portfolio-balance channel is activated through central bank operations such as outright purchases of securities, asset swaps and liquidity injections, which modify the size and the composition of the balance sheet of both the central bank and the private sector. The central bank is the only economic player that can conduct this kind of intervention on a large scale since, in principle, it can expand its balance sheet indefinitely owing to its monopolistic power in the provision of monetary base.<sup>24</sup>

The central bank's outright purchases and swap operations aim to influence prices in some specific dysfunctional segments of the financial market or to affect yields more widely. The latter is the case, for example, when the conventional monetary policy instrument is constrained at the zero lower bound and, to provide further stimulus to the economy, the central bank decides to purchase government bonds to reduce the returns on a wide range of financial assets. The efficacy of this channel hinges on the imperfect substitutability among private sector's balance sheet items, which arises in the presence of economic frictions (e.g. asymmetric information, limited commitment and limited participation), and on the impact that changes in the supply of private assets and liabilities have on individual decisions.<sup>25</sup>

Imperfect substitutability on the asset side of the private sector balance sheet has been proposed by the preferred-habitat theory, first introduced by Modigliani and Sutch (1966) and recently included in a more formal model for the interest rate term structure by Vayanos and Vila (2009). According to the preferred habitat view, whenever there is a group of investors with preferences for specific maturities (typically long-term, as is the case of pension funds and life-insurance companies), the net supply of securities at that maturity is a determinant of their yields. In this setup, changes in the net supply of assets of a given maturity by the central bank or government affect the yields of the assets. Moreover, when agents are heterogeneous, either because some of them are locked into their portfolio choices or because they have different degrees of risk-aversion (Ashcraft, Garleanu and Pedersen 2010) or different impatience to consume (Curdia and Woodford 2010), open market operations have distributional effects with potential influence on real activity and inflation.

The items on the liability side of the private sector balance sheet also become imperfect substitutes when the economic environment is characterized by the presence of information asymmetries or limited commitment. In this situation external funds tend to be charged with an extra return (with respect to the opportunity cost of internally generated funds) which depends, in general, on the severity of the friction and on the quality of the borrower's assets. In some cases external funds might even be rationed.<sup>26</sup> During a financial crisis, when the health of the

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<sup>24</sup> The central bank is constrained in expanding its balance sheet only to the extent that this undermines its credibility.

<sup>25</sup> On the contrary central bank/government purchases are ineffective when financial assets are perfectly substitutable and changes in the composition of government's portfolio do not involve distortionary changes in taxes. Wallace (1981), Eggertson and Woodford (2003).

<sup>26</sup> There is a vast literature on the role of financial frictions in shaping economic dynamics. According to the credit channel theory the presence of financial frictions amplifies the effects of monetary policy on the real economy through the effects that policy decisions have on the health of the balance sheet of private agents and, in turn, on the external premium. For a review of this literature see Bernanke and Gertler (1995). More recent analyses include

balance sheet deteriorates and confidence collapses, the extra return charged on external funds might become very large and lenders might be willing to provide funds only for very short periods of time.

To avoid a collapse of credit availability the central bank can enhance its liquidity provision to depository institutions both to accommodate the increased demand for precautionary motive and to contrast the reduction in the circulation of reserves (Keister and Mc Andrews 2009; Freixas, Martin and Skeie 2009). To alleviate tensions associated with the liquidity mismatch between the asset and the liability side of private banks, it can also decide to provide liquidity for terms that are longer than normal. In this way the central bank sustains the provision of credit to the economy and reduces term spreads.

However, a too prolonged recourse to these unconventional measures might create market distortions and increase significantly the central bank's financial risk.<sup>27,28</sup> Christiano and Ikeda (2011) provide one caveat associated with the use of unconventional measures, arguing that their effectiveness might depend on the specific set of financial frictions that affect economic behaviour.<sup>29</sup>

#### **4. Unconventional monetary policy in practice**

In this section we review the empirical literature on the effectiveness of the unconventional measures adopted by the Fed and the ECB. We classify the various studies according to whether they measure the impact of non-traditional tools (i) on financial variables or (ii) on macroeconomic variables.

The first of these two groups, which is presented in Section 4.1, is further split into four sub-categories depending on whether the measure analysed was first implemented before or after the bankruptcy of Lehman Brothers and on whether it was adopted by the Fed or by the ECB. A synthetic description of the methodology and of the main results of the various studies is reported in the tables at the end of each sub-section (Tables 3 to 5).<sup>30</sup> In Section 4.2 we review the evidence on the effects on macroeconomic variables with a summary description provided in Table 6 for both the US and the euro area.

##### **4.1 Effects of the unconventional measures on financial variables**

###### *Effects of the measures adopted by the Fed in the pre-Lehman phase*

The empirical literature on the effectiveness of unconventional measures adopted by the Fed before the bankruptcy of Lehman has mainly focused on the *Term Auction Facility*, on the *Term Securities Lending Facility* and on the *Reciprocal Currency Agreements*.<sup>31</sup>

There is no formal analysis of the other measures, namely the *Term Discount Window Program*, the *Single-Tranche Open Market Program* and the *Primary Dealers Credit Facility*. However, the heavy recourse to this group of facilities suggests that they were perceived by

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Cúrdia and Woodford (2011), De Fiore and Tristani (2009), Demirel (2009), Gertler and Karadi (2011), Gertler and Kiyotaki (2010) and Gerali, Neri, Sessa and Signoretti (2010).

<sup>27</sup> Gertler and Kiyotaki (2010) assume that unconventional monetary interventions entail some inefficiency cost.

<sup>28</sup> This risk is mitigated by the fact that central banks supply loans only against collateral.

<sup>29</sup> They argue that with moral hazard and hidden effort, the unconventional measures that have been used during the recent crisis (equity injections and credit provision to financial intermediaries) might not be effective in restoring an appropriate provision of credit to firms and households.

<sup>30</sup> In the tables we only include papers that use an econometric approach, while the studies based on more anecdotal approach are only commented in the text.

<sup>31</sup> See pages 5-7 and Table 1.

depository institutions and by primary dealers as effective in alleviating the significant funding tensions to which they were exposed during the crisis.<sup>32</sup>

The *Term Auction Facility* (TAF) was intended to fight back against dysfunctionalities in the interbank market by providing collateralized long-term liquidity to depository institutions. Taylor and Williams (2010) assess its effectiveness by measuring the impact on the Libor-OIS spread. Their analysis is based on three hypotheses. First, the Libor-OIS spread is affected by a liquidity and a credit risk, which are independent of each other. Second, the credit risk can be approximated with measurable variables (CDS on financial institutions, Libor-Tibor spread, Libor-Repo spread). Third, the TAF may only influence the liquidity risk. Constructing on these assumptions they regress the Libor-OIS spread on different measures of credit risk and a dummy variable which is set to one on the days of announcement/implementation of the TAF. These regressions fail to find any significant impact of the TAF-dummies on the Libor-OIS spread and lead the authors to conclude against the effectiveness of this measure.

McAndrews, Sarkar and Wang (2008) and Wu (2010) suggest that the baseline specification used by Taylor and Williams (2010) to measure the impact of the TAF might be inappropriate, particularly if the effect of this facility on the Libor-OIS spread is permanent. They propose two alternative approaches. McAndrews et al. (2008) substitute the dependent variable with the first difference of the Libor-OIS spread. Wu (2010) sets the TAF-dummy equal to zero before the announcement of the programme and to one thereafter.<sup>33</sup> Both analyses overturn the original result and find that the TAF reduced the 3-month Libor-OIS spread by around 50 basis points. The analysis of McAndrews et al. (2008) provides two further pieces of evidence. First, both the announcements concerning the programme and its actual implementation were effective in reducing liquidity risks. Moreover, it also turns out that both domestic and international TAF operations (currency swaps) provided a significant contribution in alleviating tensions in the interbank market.

Christensen, Lopez and Rudebusch (2009) analyse the effectiveness of the TAF using a six-factor arbitrage free representation of the term structures of risk-free (Treasuries) and risky interest rates (financial bonds and Libor).<sup>34</sup> This approach allows the authors to disentangle the liquidity risk component implicit in Libor rates and to verify whether the TAF was effective in contrasting its increase. The counterfactual exercise that is reported in the paper suggests that the TAF lowered the liquidity risk component of 3-month Libor rates by around 70 basis points over the period December 2007 to mid-2008.

Thornton (2010) disputes this finding claiming that financial bonds and Libors are influenced by different credit risks. In particular, he argues that the narrowing of the Libor – financial bond spread observed after the implementation of this unconventional measure was not due to a reduction of liquidity premia in the interbank market but to an increase in the credit risk on financial bonds due to a more pessimistic view of the depth of the crisis.

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<sup>32</sup> Recourse to the Term Discount Window Facility and to the Primary Dealers Credit Facility reached a value close to \$100 billion and \$150 billion respectively after the bankruptcy of Lehman (Adrian, Burke and McAndrews 2009). Auctions associated with the Single-Tranche Open Market Program were characterized by very high bid-to-cover ratios (2.8 on average until August 2008).

<sup>33</sup> Wu (2010) also differs with respect to Taylor and Williams (2010) for a slightly different definition of banks' counterparty risk (first principal component of a large set of CDS on both commercial and investment banks) and for the hypothesis that bank's counterparty and liquidity risks might be correlated.

<sup>34</sup> Three factors – constant, slope and curvature – are used to model the dynamics of “risk-free” Treasury rates. Two more factors are used to capture the counterparty risk implicit in financial bonds and the last factor is used to measure the liquidity risk component of the Libor. According to Christensen et al. (2009) liquidity premia affect Libor rates and financial bonds' yields in different ways because the holders of the latter class of assets have a higher tolerance than banks with regard to liquidity problems. Moreover, they also suggest that financial bond returns capture short-term credit risk more precisely than long-term bank CDS.

Fleming, Hrung and Keane (2010) assess the effectiveness of the *Term Securities Lending Facility* (TSLF) focusing on the impact of the provision of Treasuries on the spread between Treasury repos and repos based on less liquid collateral. They regress repo rates and spreads on the amount of Treasuries made available through the TSLF programme taking into account the type of securities pledged as collateral and whether auctions were fully or under-subscribed. The results suggest that the TSLF was effective in contrasting tensions in the secured funding market and, in particular, in satisfying market participants' increased demand for Treasuries. According to one of the specifications presented in the paper, each extra billion of Treasuries provided through the TSLF reduced the "Agency debt-Treasury" and the "Agency MBS-Treasury" repo spreads by around 0.4 basis points on average. This implies an overall contraction of the spread of around 80 basis points.<sup>35</sup> The empirical analysis also shows that the effect of the TSLF on repo spreads was most noticeable in the case of fully subscribed operations, when the set of eligible collateral was broad and when the Treasury repo rate was far below the federal funds target rate.

Hrung and Seligman (2011) extend the analysis of Fleming et al. (2010) by taking into account that the availability of Treasuries was also affected by the Supplemental Financing Program (SFP), by changes in Government issuance, by the TARP, and by Fed's Open Market Operations (OMO). Their econometric analysis confirms that the impact of the TSLF on Treasury repo rates was significant (1 basis point for each billion of Treasuries made available to market participants) and that it was even larger during periods of intense market stress. Moreover, they also find that the TSLF was uniquely effective compared with other policies that influenced the availability of Treasuries and associate this evidence with the fact that TSLF operations were explicitly "directed" to dealers in the General Collateral repo market.

Baba and Packer (2009) study the impact of *Reciprocal Currency Agreements* on the foreign exchange (FX) swap market between the US dollar and the euro, the Swiss franc and the pound sterling. They found that the programme was effective in improving FX swap market dislocations, especially from mid-October 2008, when the Fed uncapped the amount of dollar liquidity provided. Goldberg et al. (2010), reporting formal research as well as more descriptive accounts from market participants, also conclude that dollar swap lines were effective in reducing dollar funding pressures.

#### Effects of the measures adopted by the ECB in the pre-Lehman phase

The flexibility of its operational framework has allowed the ECB to cope with the first phase of the crisis by modifying its *modus operandi* only marginally. As a consequence, the recourse to unconventional measures has been limited and has not attracted the interest of empirical researchers.

During this period the ECB made more frequent recourse to fine-tuning operations, accommodated banks' desire to front-load the reserve requirement, increased the relative provision of long-term liquidity, and offered US dollar funding to Eurosystem counterparties. These measures had two main objectives. First, to keep very-short-term money market interest rates close to the official rate; second, to counteract tensions in the euro-area money market and in US dollar funding markets. While the effectiveness of the ECB in achieving the latter target cannot be assessed without a formal analysis, the observation that in the first phase of the crisis the Eonia remained close to the official interest rate suggests that the decisions adopted by the ECB were useful in combating the volatility of the euro-area overnight rate.

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<sup>35</sup> This effect was mainly due to an increase in Treasury repo rates, evidence that confirms that the TSLF was effective in addressing the shortage of government bonds and in contrasting the emergence of settlement problems in the repo market.

**Table 3: Measures adopted by the Fed in the pre-Lehman phase: effects on financial variables**

Paper	Programme evaluated	Methodology	Variable of interest	Results	Notes
<i>Taylor and Williams (2010)</i>	TAF	Event study	Libor-OIS spread	No significant impact on the Libor-OIS spread	Dependent variable in levels; TAF dummy equal to one on announcement days
<i>McAndrews, Sarkar and Wang (2008)</i>	TAF	Event study	First-difference of the Libor- OIS spread	50 bp reduction in the Libor-OIS spread; both announcement and implementation effective	Dependent variable in differences; TAF dummy equal to one on announcement and implementation days
<i>Wu (2010)</i>	TAF	Event study	Libor-OIS spread	50 bp reduction in the Libor-OIS spread	Dependent variable in levels; TAF dummy equal to one after announcement day
<i>Christensen, Lopez and Rudebusch (2009)</i>	TAF	Multifactor arbitrage-free model for the term structure; counterfactual analysis	Libor rate	70 bp reduction in the liquidity risk component of the 3-month Libor	-
<i>Thornton (2010)</i>	TAF	Event study	Ted spread	No effect on liquidity premium in the Libor market	-
<i>Fleming, Hrung and Keane (2010)</i>	TSLF	OLS regression	Levels of repo rates and spread between Treasury repos and repos based on other less liquid collateral	0.4 bp reduction in Agency Debt-Treasury and Agency MBS-Treasury repo spreads for each extra billion of Treasury lent	-
<i>Hrung and Seligman (2011)</i>	TSLF	OLS regression	Spread between federal funds (both target and effective) and Treasury GC repos	1 bp reduction in Spread between federal funds (both target and effective) and Treasury GC repos for each billion of Treasury lent	Interaction terms show that the impact of TSLF was larger during period of stress
<i>Baba and Packer (2009)</i>	RCA	Principal component analysis and EGARCH	Deviations from the covered interest parity in FX swap	30 pb reduction in EUR/USD FX swap deviations	Sample period: Aug 2007-Jan 2009

Note: TAF = Term Auction Facility; TSLF = Term Securities Lending Facility; RCA = Reciprocal Currency Agreements.

### Effects of the measures adopted by the Fed in the post-Lehman phase

In this section we describe the empirical evidence on the effectiveness of the *ABCP Money Market Fund Liquidity Facility*, of the *Commercial Paper Funding Facility*, of the *Term ABS Loan Facility* and of the purchase of Agency debt, Agency MBS and long-term government bonds.<sup>36</sup>

The objective of the *ABCP Money Market Fund Liquidity Facility* (AMLF) was to support the liquidity of high-quality asset-backed commercial paper (ABCP) and to break the vicious circle between money market share redemptions and ABCP fire sales. Duygan-Bump, Parkinson, Rosengren, Suarez and Willen (2010) analyse both these aspects and conclude in favour of the effectiveness of this unconventional measure. In particular, using a diff-in-diff approach they show that, following the introduction of the AMLF, the reduction in redemptions was greater for those money market funds that owned a larger proportion of AMLF-eligible assets. Similarly, by comparing the yields on AMLF-eligible ABCP with those of otherwise equivalent AMLF-ineligible commercial paper they also conclude that the AMLF reduced the liquidity risk component of the former by around 80 basis points.<sup>37</sup>

The *Commercial Paper Funding Facility* (CPFF) provided a temporary liquidity back-stop to issuers of commercial paper and was intended, in particular, to limit investors' and borrowers' concerns about "roll-over risk". Anderson and Gascon (2009) and Adrian,

<sup>36</sup> See page 10 and Table 1.

<sup>37</sup> This analysis is based on the impact of the AMLF on the spread between returns on AMLF-eligible ABCP with those of the unsecured commercial paper issued by the sponsor of the same ABCP programme, which should be characterized by a similar credit risk.

Kimbrough and Marchioni (2010) observe that the heavy recourse to this facility and the fact that the implementation of the programme has prompted a significant increase in term commercial paper issuance and a sharp reduction in commercial paper spreads tend to support its effectiveness.<sup>38</sup>

A statistical assessment of the effects of the CPFF is provided by Duca (2011). He employs a VECM methodology to study the determinants of the relative use of bank loans and of debt funded by commercial paper by US firms since the early 1960s. He finds that up until the adoption of the CPFF, when corporate spreads rose, the use of commercial paper fell relative to bank loans, which could be funded with insured deposits. However, the fact that this link broke down after the implementation of the CPFF suggests that this measure may have prevented an even sharper fall in commercial paper.

With the *Term ABS Loan Facility* (TALF) the Fed provided investors with long-term loans for the purchase of newly issued high-quality ABS backed by consumer and small business loans and commercial mortgages. Agarwal et al. (2010) offer an extensive description of the ABS market and observe that the implementation of the programme was quickly followed by a recovery in ABS issuance and a reduction in the spreads between AAA-rated ABS and interest rate swaps of the order of 200-300 basis points.

Campbell et al. (2011) provide a more formal assessment of the effectiveness of the TALF with an event study approach. Their analysis is based on two assumptions. First, the announcements concerning the programme were unexpected. Second, they also postulate that, without the TALF the spreads between eligible ABS and broader financial market returns would have remained unchanged. Under these two assumptions, they study the dynamics of these ABS spreads in periods around TALF announcements, using both market and security level data. The analysis based on market level data suggests that the programme was effective. In particular, they find that the announcements led to a reduction in ABS and in CMBS spreads by, respectively, 10-60 and 50-150 basis points. The analysis based on security level data fails to find specific effects on ABS returns associated with its acceptance or rejection in the programme. The authors interpret this last evidence as suggesting that the TALF programme has affected overall market conditions for high-rate ABS without providing advantages to specific securities.

We now turn to the analysis of the effects of the *Large-Scale Asset Purchases of Agency debt and Agency MBS*. Stroebel and Taylor (2009) analyse the effect of the MBS purchases by the Treasury and the Fed with an event study methodology. In particular, they regress a measure of MBS spreads which controls for prepayment risk on different measures of credit-default risk of the underlying mortgages, on the percentage of outstanding MBS purchased at each point of the programme, and on a series of dummies that are intended to capture the effects of the announcements of the programme. Even if the results are somehow conflicting, they tend to suggest that the announcements concerning purchases in the secondary market had some effect and contributed to reduce spreads by around 30- 60 basis points. At the same time, they fail to find a relationship between the size of the purchases and the change in MBS spreads.<sup>39</sup>

The empirical pricing model adopted by Hancock and Passmore (2011) assumes that MBS yields are determined by long-term swap rates, a short-term spread between swaps and Treasuries, and a series of risk premia. The authors estimate this equation with pre-crisis data and use the estimated parameters to provide an out-of-sample assessment of the effects of the

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<sup>38</sup> During the first quarter of implementation of the CPFF the spread associated with A2/P2 commercial paper, which was not eligible for the CPFF, remained substantially stable at around 500 basis points while the spreads of CPFF-eligible securities shrank from more than 200 to around 50-100 basis points.

<sup>39</sup> Since the Fed pre-announced both the size and the pace of the purchases, this evidence is not necessarily inconsistent with the hypothesis that the size might also matter since the markets are likely to front-load the effects.

crisis on MBS yields. They are able to show that after the announcement of the MBS purchase programme the gap between actual yields on MBS and those predicted using parameters based on the pre-crisis sample (around 50 basis points) progressively shrank and, by the end of the first quarter of 2009, vanished completely. This evidence therefore suggests that the Fed's intervention improved the functioning of the MBS market.

Fuster and Willen (2010) apply an event study methodology on individual level mortgage data to assess the impact of the announcements concerning the purchase of Agency debt and MBS on the characteristics of newly issued mortgage loans and on the selection of the borrowers that apply for a mortgage. They find three main results. First, both the initial announcement and the subsequent changes to the programme led to significant reductions in the interest rates paid by borrowers. These reductions, however, were heterogeneous across mortgage contracts. Second, the intervention of the Fed coincided with a significant increase in borrowing activity, mainly for refinancing purposes as opposed to purchases of new houses. Third, the MBS programme generated a significant shift in borrowers' characteristics. In particular, refinancing activity became highly skewed towards borrowers with high credit scores. The authors conclude that the Agency debt and MBS purchase programme had a large effect on mortgage prices and jump-started activity in the primary market. Moreover, they also observe that the almost immediate market response to the announcement of the programme suggests that the effectiveness of this measure is not subject to "long and variable lags", as is the case with other consumer-targeted policies such as tax cuts.

We now focus on the empirical evidence on the effectiveness of *Large-Scale Asset Purchases of Treasuries* in lowering long-term interest rates. This issue was addressed in the literature even before the recent crisis, with largely inconclusive results. Early studies found that open market operations had very little impact on yields, supporting the view that the price of an asset does not depend on its relative supply. The most influential paper is that of Modigliani and Sutch (1967) on the effect of Operation Twist, the joint intervention in the government bond market by the Fed and the Treasury in 1961 aimed at reducing long-term interest rates while keeping short-term rates constant.<sup>40</sup> Their main finding is that the impact on term spreads is, at most, very modest. On the contrary, more recent analyses, such as Bernanke, Reinhart and Sack (2004), provide more optimistic results regarding the effectiveness of debt management operations. The Fed's purchases of Treasuries during the recent crisis spurred a series of new analyses. We classify these studies in two groups according to whether they adopt an event study approach or a more structural time series analysis. In the first group of studies, Gagnon et al. (2010) find that around the main announcements of QE1 10-year Treasury interest rates recorded a cumulative drop of about 90 basis points. The same result is documented by Yellen (2011b), who analyses a slightly different set of events. Krishnamurthy and Vissing-Jorgensen (2011) provide results for both QE1 and QE2, showing that Treasury and Agency debt yields displayed a cumulative reduction of more than 100 basis points in QE1 and around 20 points in QE2. The large difference between the responses in these two episodes suggests that there may be some factors, such as market conditions, liquidity or market expectations, which are not properly taken into account by this kind of study. Swanson (2011) provides estimates of the effects of QE2 by studying Operation Twist considering that the size of this programme as a fraction of the Treasury debt is comparable to that of QE2. His results suggest that the cumulative effect on 10-year Treasury yields would be around 15 basis points.<sup>41</sup>

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<sup>40</sup> Operation Twist was a quantitative policy in which the Fed purchased longer-term government notes while maintaining its official rate constant and the Treasury reduced the issuance of longer-term notes in favour of short-term securities.

<sup>41</sup> The fairness of this comparison is arguable as the ample difference between estimates of QE1 and QE2 in Krishnamurthy and Vissing-Jorgensen (2011) suggests that the size of the purchase programme is not the only variable that is relevant to their effectiveness. In particular, financial strains and low liquidity at the time of the

The second group of studies uses time series methods, which require selecting stronger assumptions on the data. If causal links are properly identified, those methods allow the researcher to perform policy experiments. Overall, these studies tend to find that the Fed's purchases have a significant effect on Treasury yields. In particular, a purchase of \$400 billion of long-term securities sterilized with an equivalent issuance of short-term notes would reduce 10-year Treasury yields by between 14 and 67 basis points.<sup>42</sup>

The lowest value of this range is found by Hamilton and Wu (2010) using a model based on the "preferred habitat" theory as in Vayanos and Vila (2009). They show that their results hold even when the short-term rates are at the zero lower bound and the sterilization becomes irrelevant. Gagnon et al. (2010) find similar results adopting a model that explains 10-year term spread using business cycle indicators, measures of uncertainty about economic fundamentals, and the net public sector supply of Treasury bonds. Greenwood and Vayanos (2010) find a positive correlation between the maturity structure of US government debt and the associated interest rate term structure. According to their analysis a purchase of \$400 billion of Treasury bonds would reduce long-term rates by around 40 basis points. The highest value of the range is found by D'Amico and King (2010) using data from a panel of yields at different maturities in the period in which QE1 was ongoing (March-October 2009).

The findings of both groups of studies must be interpreted with caution. Results from event studies are based on the hypothesis that announcements/actions are not anticipated, they are conditional on the specific market conditions on the day of the announcement, they usually rely on a small number of data points and, finally, they might be strongly affected by the choice of events that are included in the sample and by the hypothesis on the responsiveness of financial markets to news, i.e. the window over which changes are computed. Furthermore, even though high-frequency event studies allow measuring the correlation between changes in the supply of financial assets and variations in financial prices in a straightforward way, a causal interpretation is correct only insofar as policy announcements or actions are not a response to market conditions on that day. This note of caution is even more relevant when the analysis is based on time series data with a monthly or even lower frequency: since the supply of government bonds is influenced by the interest rate structure, the identification of the link of causality from the former to the latter requires strong and perhaps arguable hypotheses.

Summing up, the evidence on the effectiveness of purchases of Treasury bonds in lowering long-term interest rates suggests that central banks have some power, although considerable uncertainty still surrounds the exact quantification of the impact.

The evidence on the ability of the Fed to use *communication to control market expectations* about future short-term and, in turn, long-term interest rates is scant. According to Yellen (2011a), the statements of the December 2008 and January 2009 FOMC meetings suggesting that short-term rates would remain low "for some time" favoured a decline in market expectations about the one-year-ahead federal funds rate by about 90 basis points.

Courtois, Haltom and Hatchondo (2011) explore the possibility that the effectiveness of forward guidance could be enhanced by asset purchases which transmit information about the likelihood of policy interest rates remaining low for a long time. They find some evidence in support of this hypothesis. However, they also observe that the exact magnitude of the effect cannot be accurately evaluated as the announcement might also influence the risk premium implicit in financial assets from which market expectations are extracted.

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operations as well as the zero lower bound on the short-term interest rates are other important factors that could influence the effectiveness of purchase programmes.

<sup>42</sup> This is the experiment proposed by Hamilton and Wu (2010).

**Table 4: Measures adopted by the Fed in the post-Lehman phase: effects on the financial variables**

Paper	Program me evaluated	Methodology	Variable of interest	Results	Notes
<i>Duygan-Bump, Parkinson, Rosengren, Suarez and Willen (2010)</i>	AMLF	Difference-in-difference estimation	Spread between returns on ABCP of a given issuer and the returns of the unsecured commercial paper issued by the sponsor of the same ABCP programme	Reduction of about 80 bp in the yields on ABCP	-
<i>Duca (2010)</i>	CPFF	VEC model; linear regressions	Commercial paper – bank loan mix	Implementation of the CPFF coincided with a break in the relationship between the “commercial paper – bank loan mix” and the corporate - Treasury bond spread.	-
<i>Campbell, Covitz, Nelson and Pence (2011)</i>	TALF	Event study	Spreads of the ABS that were eligible for the TALF and spreads on broad market indices	Reduction of 10-60 bp in spreads of highly rated ABS after announcement in March 2009	-
<i>Stroebel and Taylor (2009)</i>	Purchases of Agency debt and Agency MBS	Event study	MBS spread	Reduction of 30-60 bp in spreads on secondary markets after announcement of LSAP.	Results are conflicting across specifications and markets
<i>Hancock and Passmore (2011)</i>	Purchases of Agency debt and Agency MBS	Empirical pricing models (OLS regressions)	MBS yields, mortgage rates	Reduction of about 50 bp in undue risk premia in MBS yields. The gap between actual MBS yields and “counterfactual” projections based on pre-crisis data disappears by 2009-q1	-
<i>Fuster and Willen (2010)</i>	Purchases of Agency debt and Agency MBS	Event study based on individual level mortgage application and origination	Effects on price and quantities of US primary mortgage market	Boost in market activity (mainly refinancing); significant reductions in mortgage rate for high-quality borrowers	-
<i>Gagnon et al. (2010)</i>	LSAP Treasuries	Event study; changes in yields in the days of announcement	2 yr- and 10-yr Treasury yields, 10-yr agency debt yield, 10-yr swap rate Baa corporate bond index yield	Change in 10-yr Treasury yields: -91 bp	Sample period: Nov 2008 - Nov 2009
<i>Yellen (2011b)</i>	LSAP Treasuries	Event study; changes in yields on the days of announcement	10-yr and 30-yr yields on Treasuries, TIPS, MBS and corporate bond yields	Change in 10-yr Treasury yields: -107 bp	Sample period: Nov 2008 – Mar 2009
<i>Krishnamurthy and Vissing-Jorgensen (2011)</i>	LSAP Treasuries	Event study; changes in yields on the days of announcement	Treasury yields at various maturities, agency debt, MBS corporate yields & TIPS	Change in 10-yr Treasury yields: -100 (QE1); -30 (QE2)	Sample period: Nov 2008 - Mar 2009; Aug 2010 - Nov 2010
<i>Swanson (2011)</i>	LSAP Treasuries	Event study	10-yr Treasury yields	Change in 10-yr Treasury yields: -16 bp	Sample period: 1961-1962
<i>Hamilton and Wu (2010)</i>	LSAP Treasuries	Times series study	10-yr Treasury yields	Following Fed purchase of \$400bn of long-term Treasury securities and equivalent sale of short-term notes 10 yrs Treasury yields drop by 14 bp	Sample period: 1990-2007
<i>Gagnon et al. (2010)</i>	LSAP Treasuries	Times series study	Term premium on 10-yr Treasury yields	Impact on 10-yr Treasury yields following a 1% drop in the net supply of long-term government bonds over GDP: between -7 and -10 bp	Sample period: Jan 1985 – Jun 2008
<i>Greenwood and Vayanos (2010)</i>	LSAP Treasuries	Times series study	Treasury spreads: 5-yr over 1-yr and 20-yr over 1-yr	Following Fed purchase of \$400bn in long-term Treasury securities and equivalent sale of short-term notes 5 over 1-yr spread (20 over 1-yr spreads) drops by 39 (74 bp)	Sample period: 1952-2006
<i>D'Amico and King (2010)</i>	LSAP Treasuries	Panel data study	10-yr Treasury yields	Fed purchases \$400bn in long-term Treasuries: -67 bp	Sample period: Mar 2009 – Oct 2009

Note: AMLF = ABCP Money Market Fund Liquidity Facility; TSFL = Term Securities Lending Facility; CPFF = Commercial Paper Funding Facility; TALF = Term ABS Loan Facility; LSAP Treasuries = Large-scale asset purchases of Treasuries.

### Effects of the measures adopted by the ECB in the post-Lehman phase

The evidence on the effectiveness of the unconventional measures adopted by the ECB is scarcer than for the US. Abbassi and Linzert (2011) analyze the evolution of Euribor rates at various maturities before and after August 2007. They show that between 2004 and mid-2007, their dynamics were determined to a large extent by future expectations about the overnight rate and they were not affected by the amount of outstanding liquidity. On the contrary after the outburst of the crisis, and in particular after the bankruptcy of Lehman, Euribor rates became sensitive to outstanding liquidity. According to their estimates the average increase in the outstanding liquidity offered by the Eurosystem (60% more than in the period 2004-2007) reduced the Euribor rates by around 100 bp. Moreover they also show that the announcement of the introduction of 12-month long-term refinancing operations had a further, although modest, downward effect on the 12-month Euribor.

Angelini, Nobili and Piccillo (2011) employ a panel data analysis based on individual bank data and exchange-level information on interbank loans. The main objective of their research is to verify if, after the outburst of the financial turmoil in August 2007, banks have become more reactive to borrowers' characteristics. They also provide an assessment of the effect of the adoption of the *Fixed-Rate Full-Allotment procedure* (FRFA) on money market rates. Their findings suggest that only the announcements related with the 1- and 3-month refinancing operations had a positive impact on market conditions, reducing the spread between interest rates on unsecured and secured loans by about 10-20 basis points. This evidence does not necessarily points toward a limited effect of the FRFA procedure since its first-order impact is likely to have been on the level of both secured and unsecured interbank interest rates.

Beirne et al. (2011) analyze the effects of the *Covered Bond Purchase Programme* (CBPP) on the issuance and on the yields of covered bonds. Using an extensive set of analytical approaches which includes event studies, cointegration analysis and linear regressions they find that the implementation of the CBPP had a positive impact on the outstanding amount of covered bonds. However the more muted impact on the overall amount of both covered and uncovered bond suggests a possible crowding out effect between these two classes of financial assets. The CBPP is also shown to have had a positive effect on secondary markets: in the second half of 2009 the spreads between the yields on covered and agency bonds in Germany and France fell by around 50 bp and even larger declines were observed in other countries of the euro area. A more formal linear regression analysis, which takes into account the effects of the sovereign crisis and of other factors, confirms this evidence, although suggesting a more limited impact on the spreads (between 10 and 20 bp).

There is yet no available econometric analysis on the effectiveness of the *Securities Markets Programme* (SMP). Anecdotal evidence and market participants' reports suggest that this programme has contributed to prevent a potential market meltdown in May 2010 and that it has been effective in addressing the severe dislocations that were spiralling out of control at that time. The identification and the exact quantification of the effects of the SMP, however, is prevented by the fact that its announcement coincided with the Ecofin decision to start a comprehensive package of measures (including the EFSF and the EFSM) aimed at assisting EU Member States under financial stress. Immediately after resuming the SMP in August 2011, the yields on government bonds of Italy and Spain dropped dramatically; afterwards, they stabilized, but on a relatively high level. It is too early to provide a robust evaluation of the effects of the purchases.

**Table 5: Measures adopted by the ECB in the post-Lehman phase: effects on financial variables**

Paper	Program evaluated	Methodology	Variable of interest	Results
<i>Abbassi and Linzert (2011)</i>	FRFA in refinancing operations	Event study; OLS regressions	Euribor rates	100 bp reduction in Euribor rates; significant (but limited) impact of the announcement of 12-month LTRO operations on 12-month Euribor
<i>Angelini, Nobili and Piccillo (2010)</i>	FRFA in refinancing operations	Panel data study based on interest rates on actual unsecured interbank loans (E-Mid)	Spread between unsecured and secured interbank loans	Around 10-20 bp reduction in the interbank spreads
<i>Beirne et al. (2011)</i>	CBPP	Event study, cointegration analysis and linear regressions	Issuance of covered bonds; spread between covered and agency bonds	Positive impact on the issuance of covered bonds; crowding out of uncovered bonds; around 10-20 bp reduction of the spread between covered and agency bonds

*Note:* FRFA =Fixed rate full allotment in refinancing operations; CBPP = Covered Bonds Purchase Program.

## 4.2 Effects of the unconventional measures on macroeconomic variables

This section reviews the evidence on the effects on output, inflation and other relevant macroeconomic variables of the unconventional monetary policy measures put in place by the Fed and by the ECB during the recent crisis.

Ideally, in order to gauge the effectiveness of unconventional measures, one would like to answer the question “what would have happened to output and inflation had the unconventional monetary policy measures not been introduced?”. Providing a convincing answer to such question is at best very difficult. For this reason the literature has generally tried to answer the related, but easier, question “what is the effect on output and inflation of a reduction in the long-term interest rates or credit spreads due to unconventional measures?”.

Most of the studies that analyze the macroeconomic effects of the non-traditional measures adopt as a starting point of their analysis specific point estimates obtained from one of the papers presented in Section 4.1 or from narrative evidence. The channels through which the reduction in interest rates propagates to the real activity and prices are the usual ones: reduced borrowing costs that stimulate the investment and spending decisions; higher stock valuations that have positive wealth effects; depreciation of the nominal exchange rate, which stimulates the export sector. So, in principle, the transmission mechanism is apparently not very different from the one of a more conventional reduction in short-term rates.

The studies on the macroeconomic effects follow two approaches: VAR analysis, which imposes little structure on the data, and more structural models, such as medium-scale DSGE model or central banks’ large-scale econometric models. Baumeister and Benati (2010) estimate a structural time-varying VAR and identify a “pure spread shock”, which increases the long-term rates without affecting the short-term ones. They find that this type of shock has important effects on real activity and prices in several industrialized countries. Using the estimates by Gagnon *et al.* (2010) of the effects of LSAP program on the term premia in the US, they analyse the dynamics of output and inflation had the reduction in the term spread not happened. They claim that central bank’s purchases have prevented a large deflation and a strong collapse of output. According to their median estimates, GDP would have contracted by 10% in the first quarter of 2009 and inflation would have likely remained negative in most of 2009.

Lenza, Pill and Reichlin (2010) adopt a similar approach to evaluate the impact of unconventional measures on the euro area economy. They estimate a large Bayesian VAR and assume that the reduction in the spread between unsecured and secured money market rates observed between November 2008 and August 2009 was entirely due to the non-standard measures of the ECB. By comparing the forecasts of the main macro variables conditional on the observed path of money market spreads and a no-policy scenario in which the spreads remained constant at the level of October 2008, they conclude that in the absence of the ECB intervention credit dynamics would have been much more depressed. According to their

estimates the growth rate of industrial production would have been 3 percentage points lower at mid-2010 and inflation would have been about 0.5 percentage point lower at the beginning of 2010. Some caution is required in interpreting these results, as the authors assume that after 2007 the coefficients of the reduced form representation have not changed.<sup>43</sup> Moreover, the no-policy scenario is constructed assuming that the entire reduction of the spread is attributable to unconventional measures, which may be questionable (at the same time the ECB cut decisively the official rates and government interventions were undertaken).

In a more recent paper, Giannoni, Lenza, Pill and Reichlin (2011), compare the actual dynamics of monetary and credit variables during the financial crisis with their forecasts (conditional on industrial production) obtained from a Bayesian VAR estimated on the pre-crisis data. The authors find that the prediction errors for some of these variables are statistically not significant and interpret this result as evidence of the success of the non-standard measures in insulating monetary and credit aggregates from the impact of the financial crisis.

Peersman (2011) uses a structural VAR to provide some stylized facts about the transmission of unconventional interventions in the euro area. The author defines an innovation to bank credit as an “unconventional monetary policy shock”. The assumption is that ECB unconventional measures were able to boost bank credit volumes, through changes of the size and composition of its balance sheet. According to the evidence presented in the paper the transmission of the “unconventional” monetary shock has the same features of the transmission of standard monetary shock, namely a hump-shaped response of output and a permanent, but delayed, response of prices, although the propagation is in general more sluggish.

A second group of papers study the macroeconomic effects of unconventional measures using general equilibrium structural models. The main advantage of this approach is that a proper counterfactual can be constructed more easily without incurring in the Lucas’ critique. The drawback is that these models are more difficult to estimate. Del Negro et al. (2010) build a fully-fledged DSGE model, including financial frictions *à la* Kiyotaki and Moore (2008). Calibrating this model to match features of the US economy, they find that the extraordinary monetary policy intervention of the Fed, that in the model is constructed as a swap of liquid for illiquid assets (the portfolio-balance channel), prevented a major collapse in output and the risk of persistent deflation. According to their model, this policy measure is especially effective when the economy reaches the zero lower bound.

Chung *et al.* (2011) measure the impact of the LSAP program using the FRB/US model, augmented to analyze portfolio-balance channel effects. The term premium in the model is assumed to be proportional to the discounted future expected Fed holdings of long-term securities as a ratio of nominal GDP. The model simulations have the advantage of considering not only the initial impact of the asset purchases but also the effects of the evolution of the program. They show that the LSAP program boosts output by almost 3% above the baseline in the second half of 2012, raises employment by about 3 million jobs and keeps inflation about 1 percentage point higher than in the no-intervention scenario. According to the model, this would have corresponded to a reduction in the federal funds rate, relative to the baseline, of about 300 basis points relative since early 2009.

Fuhrer and Olivei (2011) assume that the reduction in US long-term interest rates due to QE2 is quantifiable at around 20-30 basis points (as found in Gagnon et al., 2010 and Hamilton and Wu, 2010) and estimate its effect on real GDP and unemployment. Combining information from a VAR, the Boston Fed and the FRB/US models, they find that the implied increase in real

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<sup>43</sup> This is difficult to justify given the depth and strength of the financial crisis and the global recession observed in the following years.

GDP is around 60-90 basis points over two years, while the drop in the unemployment rate over the same period is slightly less than half a percentage point.

Some papers have focused on the effects of the unconventional measures on specific euro-area countries. Locarno and Secchi (2009) provide an assessment regarding the Italian economy. Their results suggest that the abundant provision of liquidity in the euro area reduced the spread between unsecured and secured interbank rates by around 100 basis points and that this reduction was reflected in a similar decline in Italian short-term lending rates. The authors measure the impact of this interest rate change on output growth by means of the Bank of Italy Quarterly Model and conclude that the non-standard decisions of the ECB prevented a further decline of around 1 per cent in Italian output (cumulative over the three years 2008-2010). Given the evidence of some credit rationing during the crisis, they also observe that an assessment of the impact of the unconventional measures that neglected the effects on credit availability would significantly underestimate their importance.<sup>44</sup>

**Table 6: Effects of the unconventional measures on macroeconomic variables**

Paper	Country	Methodology	Description of the exercise	Macroeconomic effect		
				Output	Inflation	Other
<i>Baumeister and Benati (2010)</i>	US	Structural time-varying VAR	Identification of a "pure spread" shock (i.e. a shock that affects the long-term rate leaving the short-term rate unchanged). Simulation of the effects of the reduction in the spread estimated by Gagnon et al. (2010) on some macroeconomic variables.	GDP would have contracted by 10% in 2009q1	-	-
<i>Lenza, Pill and Reichlin (2010)</i>	Euro area	Large Bayesian VAR	Comparisons of conditional forecasts of some macroeconomic variables in the case in which the spreads between unsecured and secured money market interest rates had remained at the peak of October 2008.	Industrial production would have been 3 pp lower in mid-2010	Inflation would have been 0.5 pp lower at the beginning of 2010	Loans to non-financial corporations would have been 3 pp lower in mid-2009
<i>Peersman (2011)</i>	Euro area	Structural VAR	Identification of "unconventional monetary policy shocks" as innovations to bank credit orthogonal to monetary policy. Analysis of the transmission mechanism of this shock.	Hump-shaped response of output after the shock. More sluggish propagation compared to a "conventional" monetary policy shock.	Permanent and delayed response of prices. More sluggish propagation compared to a "conventional" monetary policy shock.	-
<i>Del Negro, Eggertsson, Ferrero and Kiyotaki (2010)</i>	US	Calibrated DSGE model	Large-scale DSGE model with financial frictions. Assessment of the macroeconomic effects of a swap of liquid for illiquid assets by the central bank with and without the zero lower bound.	Output about 5 pp lower (in deviation from the baseline) after the shock	Inflation about 5 pp lower (in deviation from the baseline) after the shock	-
<i>Chung et al. (2011)</i>	US	FRB/US model	Simulation of the macroeconomic effects of central bank asset purchases in the large-scale macroeconomic model used at the Federal Reserve Board augmented with a term premium that depends on the net supply of assets.	Real GDP is boosted by almost 3% above the baseline in the second half of 2012	Inflation is 1 pp higher in 2012	Overall increase in employment by about 3 million jobs
<i>Fuhrer and Olivei (2011)</i>	US	VAR, Boston Fed and FRB/US models	Study of the effects of purchases of \$600 bn of long-term Treasuries	Real GDP should rise by 60-90 bp two years after the announcement.	-	Unemployment rate should decline by 30-45 bp over the two years.

<sup>44</sup> On the effects of credit rationing on the Italian economy during the recent crisis, see also Caivano et al. (2010) and Gaiotti (2011).

Summing up, the research on the macroeconomic effects of unconventional monetary policy suggests that the interventions of the Fed and the ECB were crucial in avoiding a collapse in output and the threat of deflation. Although we share this general conclusion, in our view the magnitude of the stimulus is subject to large uncertainty, both on the upside and on the downside, for four reasons.

First, most results are based on estimates of the impact of the unconventional measures on long-term interest rates that are still very uncertain. Second, in most cases they are based on the assumption that the global crisis had no effect on the relationship between macroeconomic variables; this need not be the case, as uncertainty and loss of confidence could severely impair the normal functioning of the economy. Third, studies of the macroeconomic effects of unconventional measures that focus exclusively on their impact transmitted through financial prices (such as market spreads) may underestimate the overall effectiveness of the interventions in presence of credit rationing: they do not capture the possible benefits in terms of greater availability of credit and liquidity in the economy. Finally, most of models used do not feature a fully fledged financial system, which is necessary to make a sound inference about the effects of the unconventional measures.

## **5. Conclusions**

The Fed and the ECB implemented a series of unconventional monetary measures aimed at avoiding a meltdown of the financial system and mitigating the effects of the turmoil on the real economy and on prices. The Fed modified its operational framework on many levels; the innovations implemented by the ECB were also substantial, but somehow less pervasive, due to a series of factors. First, the operational framework of the ECB was already very flexible before the crisis and therefore only modest modifications were needed. Second, in the US, capital markets play a more important role in providing credit to the economy than in the euro area. This implies that while the ECB could limit its efforts to improving and expanding the provision of funds to the banking system, the Fed had to resort to more innovative measures with broader scope. Third, in the US the impact of the crisis on the inflation outlook was more acute. This led the Fed to slash official interest rates to zero and to start a programme of asset purchases to reduce long-term yields and so provide further stimulus to the economy and avoid a deflation spiral. The difference in the size and scope of the unconventional measures adopted by the two central banks is reflected in the larger increase in the size of the Fed's balance sheet and in the more noticeable changes in its composition.

A deeper understanding of the relative role of the different unconventional measures in preventing disruptions and in restoring normal conditions in financial markets is a crucial ingredient for the selection of the instruments that should be included in the central banks' crisis toolbox. In this respect, the analysis of the theoretical underpinnings of the functioning of these measures and of the empirical evidence on the effectiveness of each of the specific unconventional measures adopted by the Fed and by the ECB can be of great help.

The literature suggests that unconventional interventions may affect economic variables through two channels of transmission: the signalling channel and the portfolio-balance channel. The first is activated through communication and allows the central bank to restore confidence in the financial markets and to influence private expectations about future policy decisions and, in turn, long-term interest rates. The second operates when assets, and liabilities, in the balance sheets of the private sector are imperfectly substitutable. In such a situation the central bank might resort to asset purchases and liquidity injections to influence the prices of a wide set of securities and to mitigate the impact of financial frictions on funding conditions.

The review of the existing empirical literature on the unconventional measures put in place by the Fed and the ECB since August 2007, and up to mid-2011, leads to the following considerations. First, as far as concerns the effects on financial market conditions, the available evidence suggests that most of the unconventional measures adopted by the Fed and the ECB have been effective: in some cases, the estimated effects are sizeable. In the US the adoption of the TSLF was helpful in counteracting the limited availability of Treasuries and coincided with a decline in the spread between Treasury repos and Agency MBS repos of around 80 basis points; a similar effect was exerted by the AMLF on the yields on asset-backed commercial paper; an even larger impact on ABS yields (around 200-300 basis points) is associated with the implementation of the TALF. As regards the effects of purchases of long-term Treasury bonds in the first round of quantitative easing, the estimates, based on time series models, suggest that long-term interest rates decreased by about 30-150 basis points. In the euro area the ECB's decision to provide liquidity to the banking system using an FRFA procedure is estimated to have reduced Euribor rates by around 100 bp, while the CBPP is estimated to have decreased the covered bond spreads by about 10-50 basis points.

Second, the degree of uncertainty that surrounds these results is very large, however. For example, the measurement of the effectiveness of the TAF in reducing the Libor-OIS spread ranges from zero to around 70 basis points depending on the econometric approach and on the specific variables adopted in the analysis. A similar range is observable in the measurement of the effects of the purchases of Treasuries on long-term interest rates (from 10 to more than 100 basis points). These differences are due to a large degree of heterogeneity in the selection of the variables used in the analysis and in the identification techniques. Further research is needed to better understand: (i) the determinants of the various risk premia that affect the returns on financial assets (e.g. counterparty, liquidity, term, etc.); (ii) how they are intertwined in normal times and during periods of financial stress; and (iii) how they can be influenced by unconventional measures of monetary policy. The availability of more sound theoretical underpinnings would help in the selection of the proxies for the risk premia and in the design of the appropriate econometric methodology. The classification of the transmission channels of unconventional measures, as illustrated in the first part of the paper, is a step in this direction, but further analysis is necessary.

Third, the available evidence on the macroeconomic effects suggests that the interventions of the Fed and the ECB were crucial in avoiding a larger collapse in output, persistent deflation and in sustaining credit growth. Still, the magnitude of the stimulus is very uncertain for four reasons. First, most macroeconomic results are inferred from very uncertain estimates of the impact of the unconventional measures on long-term interest rates. Second, they are based on the assumption that the crisis had no effect on the relationship between macroeconomic variables. Third, the existing studies may underestimate the effectiveness of the interventions because they do not fully capture the role of the unconventional measures in contrasting forms of credit rationing. Finally, the models used in the analyses generally lack a fully-fledged description of the financial system.

To sum up, the available evidence suggests that the central banks interventions were effective; they avoided a financial meltdown, in the presence of an impaired monetary transmission mechanism and, in the case of the Fed, a binding zero lower bound for interest rates. However, a definite assessment of the overall benefits and costs of unconventional measures is not yet possible. A fundamental issue, that is not addressed in this paper but is crucial to a comprehensive evaluation of the whole policy experiment, is the costs that central banks may incur to reverse their unconventional policies. It remains an issue to measure, and minimize, the distortions associated with prolonged use of non-market-based liquidity provision mechanisms; in the longer term, the withdrawal of those operations that have permanent effects on the central banks' balance sheets may pose some challenges.

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