Chapter One

Unconventional Monetary Policy in Theory and in Practice

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Abstract

In this chapter, after discussing the theoretical underpinnings of unconventional monetary policy measures, we review the existing empirical evidence on their effectiveness, focusing on those adopted by central banks, particularly the Federal Reserve. These measures operate in two ways — through the signaling channel and through the portfolio balance channel. In the former, the central bank uses communication to steer interest rates and to restore confidence in the financial markets; the latter hinges on the 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 in some markets. Our review of the empirical literature suggests that the unconventional measures were effective and that their impact on the economy was sizeable. However, a large degree of uncertainty surrounds the precise quantification of these effects.

1. Introduction

In normal times, central banks implement monetary policy by steering official interest rates and explaining to the public how a particular

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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 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.¹ Moreover, during normal times, the central bank is only concerned about injecting the banking system with the appropriate amount of reserves while their distribution among depository institutions takes place through the interbank market.

The monetary impulse is then transmitted through different channels to all the other financial markets.² 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 conventional transmission mechanism.

However, implementing monetary policy is a much more complex exercise during a financial crisis, as the transmission mechanism can be severely impaired by disruptions in the financial markets. First, 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

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

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

real economy is large, the zero lower bound for interest rates may become a binding constraint for monetary policy decisions.³ In these situations, central banks may need to resort to unconventional measures to regain control on the economy.

There is not a universally accepted definition of a non-standard monetary policy measure; indeed, the difference between a conventional and an unconventional tool might, in some cases, be quite tenuous.⁴ 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, including 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 varied across countries. This reflected the differences in the structure of the respective financial systems, in the severity of market disruptions, and the role of central banks' judgment. During unconventional times, this last factor contributes more because of the lack of both sound theory and empirical evidence on the effectiveness of non-standard measures (Trichet, 2010). To fill this gap, and to increase our understanding of the mechanisms through which unconventional monetary measures influence the economy, the profession intensified its research activities in this area.

In this chapter, we touch on measures adopted in the U.S. during the global financial crisis, we provide a review of the main theoretical underpinnings that support the use of unconventional measures, and we survey the evidence on their effectiveness. While these measures may have

³“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.*, 2012).

⁴While 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.

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 of them is a necessary step towards defining an “optimal unconventional tool-box” to deal with future crises.

The theoretical literature on the functioning of unconventional policy tools identifies two transmission channels.

The *signaling channel* 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 both 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.

Our review of the theoretical and empirical evidence suggests that the unconventional measures have been effective in influencing financial and macroeconomic variables. However, considerable uncertainty surrounds the quantification of these effects.

The chapter is organized as follows. Section 2 analyses the theoretical support for the effectiveness of the unconventional measures adopted in the U.S. up to mid-2011. Section 3 surveys the empirical evidence, and Section 4 concludes.

2. Unconventional Monetary Policy in Theory

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

2.1. The signaling channel

The signaling channel is activated through central bank’s communications informing the public about its intentions regarding the future evolution of

short-term interest rates, 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 signaling 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.⁵ 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.⁶

In the literature, the signaling 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 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 signaling 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.

During the financial crisis, the Fed provided forward guidance about the likely path of the federal funds rate to promote economic recovery and

⁵ An exhaustive analysis of the role of communication in monetary policy is provided by Blinder *et al.* (2008); Ferrero and Secchi (2009; 2010) analyze the effects and the desirability of communication of the future interest rate path in “normal” times.

⁶ 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.

price stability. However, the central bank 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.⁷ Clarida (2012) 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 the 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

⁷“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).

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 behavior even before any action is taken.⁸ The information released, concerning the size, speed and, more in general, the terms of the intervention, is crucial for the effectiveness of the signaling channel. The central bank's optimal degree of transparency must trade off the credibility and effectiveness potentially gained with a clear and transparent plan against the risks of providing inappropriate incentives to the market participants and of higher volatility due to not meeting market expectations.

2.2. *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 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.⁹

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,

⁸However, it should be taken into consideration that such an announcement may increase moral hazard and therefore contribute to risk-taking behavior.

⁹The central bank is constrained in expanding its balance sheet only to the extent that this undermines its credibility.

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.¹⁰

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, 2011) 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 generally depends on the severity of the friction and on the quality of the borrower's assets. In some cases, external funds might even be rationed.¹¹ During a financial crisis, when the health of the balance sheet

¹⁰On 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).

deteriorates and confidence collapses, the extra return charged on external funds might become quite 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 McAndrews, 2009; Freixas, Martin and Skeie, 2011). 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 significantly increase the central bank's financial risk.^{12,13} 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 behavior.¹⁴

3. Unconventional Monetary Policy in Practice

In this section, we review the empirical literature on the effectiveness of the unconventional measures adopted by the Fed. We classify the various studies according to whether they measure the impact of non-traditional tools (1) on financial variables or (2) on macroeconomic variables.

The first of these two groups, which is presented in the next subsection, is further split into two sub-categories, depending on whether the

¹¹ 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 Cúrdia and Woodford, 2011; De Fiore and Tristani, 2009; Demirel, 2009; Gertler and Karadi, 2011; Gertler and Kiyotaki, 2010; and Gerali *et al.*, 2010.

¹² Gertler and Kiyotaki (2010) assume that unconventional monetary interventions entail some inefficiency cost.

¹³ This risk is mitigated by the fact that central banks supply loans only against collateral.

¹⁴ They argue that with moral hazard and hidden effort, the unconventional measures that have been used during the great financial crisis (equity injections and credit provision to financial intermediaries) might not be effective in restoring an appropriate provision of credit to firms and households.

measure analyzed was first implemented before or after the bankruptcy of Lehman Brothers. 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 (see Tables 1.1 and 1.2).¹⁵ In the following sub-section, we review the evidence on the effects on macroeconomic variables with a summary description provided in Table 1.3.

3.1. *Effects of the unconventional measures on financial variables*

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

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 Fed aimed at preventing disorders in money markets, and implemented a series of measures to extend the availability of emergency and long-term funding to primary dealers, through which in normal times the reserves are channeled to the banking system, and depository institutions.

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*.¹⁶

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 depository institutions and by primary dealers as effective in alleviating the significant funding tensions to which they were exposed during the crisis.¹⁷

¹⁵In 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.

¹⁶See Table 1.1.

¹⁷Recourse 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).

Table 1.1: Measures Adopted by the Fed in the Pre-Lehman Phase: Effects on Financial Variables.

Paper	Program Evaluated	Methodology	Variable of Interest	Results	Notes
Taylor and Williams (2009)	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
McAndrews, Sarkar and Wang (2017)	TAF	Event study	First-difference of the Libor-OIS spread	50 basis points 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
Wu (2010)	TAF	Event study	Libor-OIS spread	50 basis points reduction in the Libor-OIS spread	Dependent variable in levels; TAF dummy equal to one after announcement day
Christensen, Lopez and Rudebusch (2009)	TAF	Multifactor arbitrage-free model for the term structure; counterfactual analysis	Libor rate	70 basis points reduction in the liquidity risk component of the three-month Libor	—

(Continued)

Table 1.1: (Continued)

Paper	Program Evaluated	Methodology	Variable of Interest	Results	Notes
Thornton (2011)	TAF	Event study	Ted spread	No effect on liquidity premium in the Libor market	—
Fleming, Hrung and Keane (2010)	TSLF	OLS regression	Levels of repo rates and spread between Treasury repos and repos based on other less liquid collateral	0.4 basis points reduction in Agency Debt-Treasury and Agency MBS-Treasury repo spreads for each extra billion of Treasury lent	—
Hrung and Seligman (2015)	TSLF	OLS regression	Spread between federal funds [both target and effective] and Treasury GC repos	1 basis points 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
Baba and Packer (2009)	RCA	Principal component analysis and EGARCH	Deviations from the covered interest parity in FX swap	30 basis points reduction in EUR/USD FX swap deviations	Sample period: August 2007–January 2009

Note: TAF = Term Auction Facility; TSFL = Term Securities Lending Facility; RCA = Reciprocal Currency Agreement.

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 (2009) 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. Building 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 (2017) and Wu (2010) suggest that the baseline specification used by Taylor and Williams (2009) 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.* (2017) 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 program and to one thereafter.¹⁸ Both analyses overturn the original result and find that the TAF reduced the three-month Libor-OIS spread by around 50 basis points. The analysis of McAndrews *et al.* (2017) provides two further pieces of evidence. First, both the announcements concerning the program 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 (2014) analyze 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

¹⁸Wu (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.

and Libor).¹⁹ 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 three-month Libor rates by around 70 basis points over the period of 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 instead, to an increase in the credit risk on financial bonds due to a more pessimistic view of the depth of the crisis.

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 program, taking into account the type of securities pledged as collateral and whether auctions were fully or undersubscribed. 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.²⁰ The empirical analysis also shows that the

¹⁹Three 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.* (2014), 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.

²⁰This 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.

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 (2015) 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 the 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 U.S. dollar and the euro, the Swiss franc and the pound sterling. They found that the program 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.

3.1.2. *Effects of the measures adopted by the Fed in the post-Lehman phase*

After the bankruptcy of Lehman Brothers in September 2008, the financial crisis became more severe and spread to the shadow banking system. In the U.S., 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 extended the provision of temporary liquidity to the most important part of the shadow banking system.

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.²¹

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) analyze both these aspects and conclude in favor of the effectiveness of this unconventional measure. In particular, using a difference-in-difference 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.²²

The *Commercial Paper Funding Facility* (CPFF) provided a temporary liquidity backstop 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, Kimbrough and Marchioni (2011) observe that the heavy recourse to this facility and the fact that the implementation of the program has prompted a significant increase in term commercial paper issuance and a sharp reduction in commercial paper spreads tend to support its effectiveness.²³

A statistical assessment of the effects of the CPFF is provided by Duca (2013). 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,

²¹ See Table 1.2.

²² 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 program, which should be characterized by a similar credit risk.

²³ 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.

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 program 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 program 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 program 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 program. The authors interpret this last evidence as suggesting that the TALF program has affected overall market conditions for high-rate ABS without providing advantages to specific securities.

A vast literature analyzed the effects of the *Large-Scale Asset Purchases of Agency debt* and *Agency MBS*. Stroebel and Taylor (2012) analyze 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 program, and on a series of dummies that are intended to capture the effects of the announcements of the program.

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.²⁴

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 crisis on MBS yields. They are able to show that after the announcement of the MBS purchase program, 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 program 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 program 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 program 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

²⁴Since 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.

the program 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.

Moving to 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 great financial crisis, with largely inconclusive results. Early studies found that open market operations had 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.²⁵ Their main finding is that the impact on term spreads is, at most, quite 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 great financial 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.* (2011) 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 program as a fraction of the Treasury debt is comparable to that of QE2. His results

²⁵Operation 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 favor of short-term securities.

suggest that the cumulative effect on 10-year Treasury yields would be around 15 basis points.²⁶

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.²⁷

The lowest value of this range is found by Hamilton and Wu (2012) 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.* (2011) 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 (2014) find a positive correlation between the maturity structure of U.S. 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 (2013), 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

²⁶The 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 program is not the only variable that is relevant to their effectiveness. In particular, financial strains and low liquidity at the time of the 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 programs.

²⁷This is the experiment proposed by Hamilton and Wu (2012).

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 permit straightforward measurement of the correlation between changes in the supply of financial assets and variations in financial prices, 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” favored a decline in market expectations about the one-year-ahead federal funds rate by about 90 basis points.

Courtois, Haltom, and Hatchondo (2011) explored 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.

3.2. 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 during the great financial crisis.

Table 1.2: Measures Adopted by the Fed in the Post-Lehman Phase: Effects on the Financial Variables.

Paper	Program Evaluated	Methodology	Variable of Interest	Results	Notes
Duygan-Bump, Parkinson, Rosengren, Suarez and Willen (2010)	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 program	Reduction of about 80 basis points in the yields on ABCP	
Duca (2013)	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.	

Campbell, Covitz, Nelson and Pence (2011)	TALF	Event study	Spreads of the ABS that were eligible for the TALF and spreads on broad market indices	Reduction of 10–60 basis points in spreads of highly rated ABS after announcement in March 2009	
Stroebel and Taylor (2012)	Purchases of Agency debt and Agency MBS	Event study	MBS spread	Reduction of 30–60 basis points in spreads on secondary markets after announcement of LSAP.	Results are conflicting across specifications and markets
Hancock and Passmore (2011)	Purchases of Agency debt and Agency MBS	Empirical pricing models [OLS regressions]	MBS yields, mortgage rates	Reduction of about 50 basis points in undue risk premia in MBS yields. The gap between actual MBS yields and “counterfactual” projections based on pre-crisis data disappears by Q1/2009	

(Continued)

Table 1.2: (Continued)

Paper	Program Evaluated	Methodology	Variable of Interest	Results	Notes
Fuster and Willen (2010)	Purchases of Agency debt and Agency MBS	Event study based on individual level mortgage application and origination	Effects on price and quantities of U.S. primary mortgage market	Boost in market activity [mainly refinancing]; significant reductions in mortgage rate for high-quality borrowers	
Gagnon <i>et al.</i> (2011)	LSAP Treasuries	Event study; changes in yields in the days of announcement	2-year and 10-year Treasury yields, 10-year agency debt yield, 10-year swap rate Baa corporate bond index yield	Change in 10-year Treasury yields: −91 basis points	Sample period: November 2008–November 2009
Yellen (2011b)	LSAP Treasuries	Event study; changes in yields on the days of announcement	10-year and 30-year yields on Treasuries, TIPS, MBS and corporate bond yields	Change in 10-year Treasury yields: −107 basis points	Sample period: November 2008–March 2009

Krishnamurthy and Vissing-Jorgensen (2011)	LSAP Treasuries	Event study; changes in yields on the days of announcement	Treasury yields at various maturities, agency debt, MBS corporate yields and TIPS	Change in 10-year Treasury yields: −100 basis points [QE1]; −30 basis points [QE2]	Sample period: November 2008–March 2009; August 2010–November 2010
Swanson (2011)	LSAP Treasuries	Event study	10-year Treasury yields	Change in 10-year Treasury yields: −16 basis points	Sample period: 1961–1962
Hamilton and Wu (2012)	LSAP Treasuries	Times series study	10-year Treasury yields	Following Fed purchase of \$400 billion of long-term Treasury securities and equivalent sale of short-term notes 10 years Treasury yields drop by 14 basis points	Sample period: 1990–2007
Gagnon <i>et al.</i> (2011)	LSAP Treasuries	Times series study	Term premium on 10-year Treasury yields	Impact on 10-year Treasury yields following a 1% drop in the net supply of long-term government bonds over GDP: between −7 and −10 basis points.	Sample period: January 1985 – June 2008

(Continued)

Table 1.2: (Continued)

Paper	Program Evaluated	Methodology	Variable of Interest	Results	Notes
Greenwood and Vayanos (2014)	LSAP Treasuries	Times series study	Treasury spreads: 5-year over 1-yr and 20-yr over 1-yr	Following Fed purchase of \$400 billion in long-term Treasury securities and equivalent sale of short-term notes 5 over 1-year spread [20 over 1-year spreads] drops by 39 [74 basis points]	Sample period: 1952–2006
D’Amico and King (2013)	LSAP Treasuries	Panel data study	10-year Treasury yields	Fed purchases \$400 billion in long term Treasuries: –67 basis points	Sample period: March 2009–October 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.

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 a question is difficult at best. 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 3.1 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; and depreciation of the nominal exchange rate, which stimulates the export sector. So, in principle, the transmission mechanism is apparently not so different from the one of a more conventional reduction in short-term rates.

The studies on the macroeconomic effects follow two approaches: (1) the VAR analysis, which imposes little structure on the data, and (2) more structural models, such as medium-scale DSGE model or central banks’ large-scale econometric models.²⁸ 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.* (2011) of the effects of LSAP program on the term premia in the U.S., they analyze 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.

²⁸ See Table 1.3.

Another strand of literature studies 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 the Lucas' critique. The drawback is that these models are more difficult to estimate. Del Negro *et al.* (2017) built a fully-fledged DSGE model, including financial frictions *à la* Kiyotaki and Moore (2008). Calibrating this model to match features of the U.S. 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.* (2012) 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 three million jobs, and keeps inflation about one 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 long-term interest rates due to QE2 is quantifiable at around 20–30 basis points (as found in Gagnon *et al.*, 2011; and Hamilton and Wu, 2012) 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 GDP is around 60 to 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.

Summing up, the research on the macroeconomic effects of unconventional monetary policy suggests that the interventions of the Fed

Table 1.3: Effects of the Unconventional Measures on Macroeconomic Variables.

Paper	Country	Methodology	Description of the Exercise	Macroeconomic Effect		
				Output	Inflation	Other
Baumeister and Benati (2010)	U.S.	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 <i>et al.</i> (2011) on some macroeconomic variables.	GDP would have contracted by 10% in Q1/2009.		
Del Negro, Eggertsson, Ferrero and Kiyotaki (2017)	U.S.	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.	

(Continued)

Table 1.3: (Continued)

Paper	Country	Methodology	Description of the exercise	Macroeconomic effect		
				Output	Inflation	Other
Chung <i>et al.</i> (2012)	U.S.	FRB/US model	Simulation of the macroeconomic effects of central bank asset purchases in the large-scale macro-econometric 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 three million jobs.
Fuhrer and Olivei (2011)	U.S.	VAR, Boston Fed and FRB/US models	Study of the effects of purchases of \$600 billion of long-term Treasuries	Real GDP should rise by 60–90 basis points two years after the announcement.		Unemployment rate should decline by 30–45 base points over the two years.

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 a 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 uncertain. Second, in most cases, they are based on the assumption that the global crisis had no effect on the relationship between macroeconomic variables when this need not be the case, as uncertainty, the deleveraging process 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 the 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.

4. Conclusions

The Fed 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.

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 can be of great help.

The literature suggests that unconventional interventions may affect economic variables through two channels of transmission — the signaling 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 since August 2007, and up to mid-2011, leads to the following considerations.

First, as far as it concerns the effects on financial market conditions, the available evidence suggests that most of the unconventional measures adopted by the Fed have been effective — in some cases, the estimated effects are sizeable. 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. With regards to 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.

Second, the degree of uncertainty that surrounds these results is large. 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 chapter, 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 were crucial in avoiding a larger collapse in output, persistent deflation, and in sustaining credit growth. Still, the magnitude of the stimulus is uncertain for four reasons. First, most macroeconomic results are inferred from 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 Fed interventions were effective; they avoided a financial meltdown in the presence of an impaired monetary transmission mechanism and 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 chapter, 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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