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**The Effectiveness of Unconventional
Monetary Policies**

October 2013

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The Effectiveness of Unconventional Monetary Policies

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Abstract

Monetary authorities throughout the world have been responding to the global financial crisis by cutting interest rates to historically low levels and by embarking on a series of unconventional monetary policies, including operations that change the size and composition of their balance sheets and actions that try to guide longer-term interest rate expectations.

In this white paper, I review the most important

unconventional monetary policies adopted by the Federal Reserve and the European Central Bank, how the transmission mechanism of such policies to the real economy differs from that of conventional interest rate changes, and the relevant macroeconomic consequences. I highlight the uncertain long-term effects of unconventional policies and concerns about potential undesired consequences of these policies.

1. Introduction

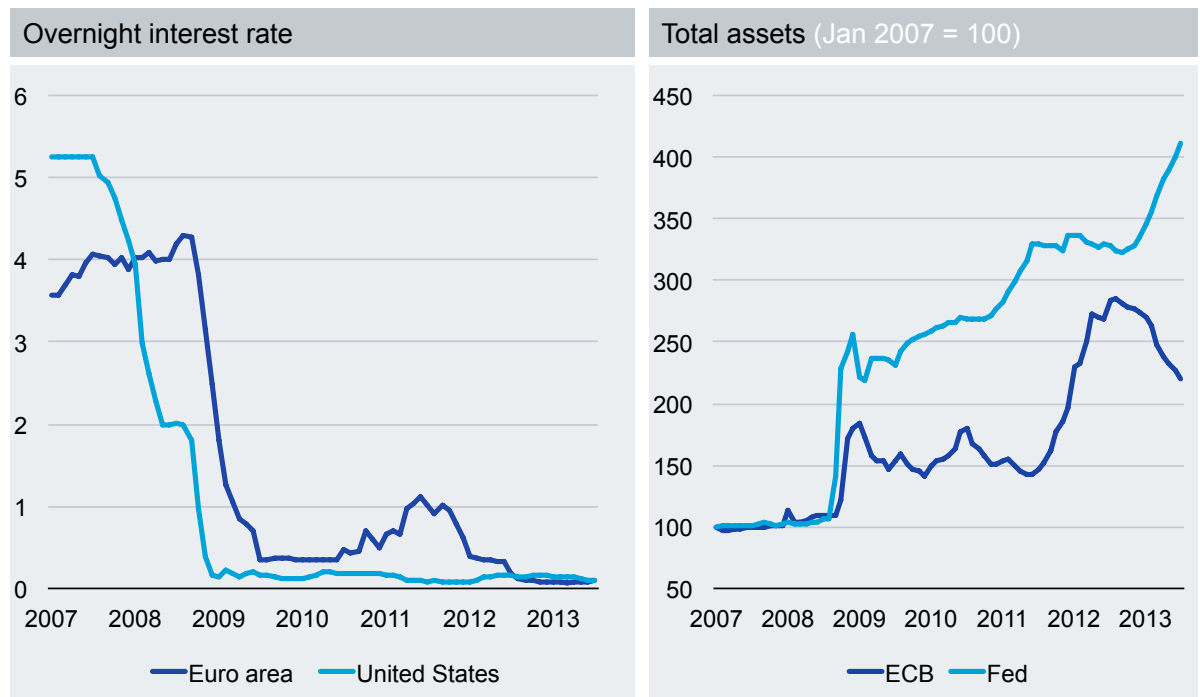
In normal times, as the monopoly supplier of banknotes and bank reserves, central banks steer overnight interest rates by altering the money supply. In particular, when they want to stimulate the economy, they lower overnight rates by increasing the monetary base. This causes other interest rates to decline as well, such as mortgage and corporate bond rates, and boosts asset prices as investors equalise risk-adjusted returns across their portfolios. As a result of lower borrowing costs and the resulting improvement in financial conditions, households and firms increase their demand for goods and services. This is the well-known conventional monetary policy transmission mechanism.

When overnight interest rates are constrained by the zero lower bound, however, central banks can no longer stimulate aggregate demand by further reductions. This is what occurred in several advanced economies following the collapse of Lehman Brothers in September 2008. As policy rates

approached and ultimately reached their effective lower bounds, the central banks of these economies adopted a variety of non-standard monetary policy measures to provide further stimulus and counter risks to financial stability. Thus, central bank balance sheets and communication policies replaced overnight interest rates as the main policy instruments.

In this white paper, I discuss the effectiveness of the Federal Reserve's (Fed) and European Central Bank's (ECB) prevalent unconventional monetary policies, and the macroeconomic effects of the accompanying increases in the sizes of their balance sheets. In general, the differences in the unconventional policies adopted by these central banks are closely related to the differences in their economies' financial structures: The euro area's financial system centers on commercial banks, while the United States' system is based primarily on capital markets. This explains why the Fed largely intervened directly in financial markets, whereas the ECB focused on measures to increase bank lending.

Figure 1. Evolution of overnight interest rates and central bank balance sheets



Source: European Central Bank and Federal Reserve Board

2. Communication policies

2.1. Shaping interest-rate expectations

The overnight interest rates themselves are peripheral to the economic decisions that the central bank wants to influence. Instead, the anticipated path of short-term interest rates determines longer-term interest rates, asset prices, and ultimately spending decisions. According to the expectations theory of the yield curve, interest rates on long-term bonds are a weighted average of current and expected short-term interest rates over the life of the long-term bond. Hence, even when the current policy rate is constrained by the lower bound, central banks can still affect asset prices and long-term interest rates by influencing market expectations for future short-term rates. More precisely, when the overnight interest rate reaches the zero lower bound, additional stimulus is possible by explicitly communicating a commitment to keep the policy rate low for a longer period than previously expected. For the forward guidance policy to work as desired, the public has to believe that the central bank will keep the policy rate lower than it otherwise would, even when economic activity and inflation begin to rise. In particular, when the time comes to follow through on the commitment, the central bank may raise rates earlier than promised to head off an increase in inflation. Consequently, forward guidance policies can only influence expectations – and hence longer-term interest rates and asset prices – to the extent that they are credible and market participants believe that the central bank will not control inflation as tightly as previously expected. In practice, the most logical way to make such a commitment credible is to communicate it publicly and unequivocally.

2.2. Forward guidance of the Fed

In contrast to the ECB, the Fed has used forward guidance immediately since reaching the zero lower bound. Specifically, in the Federal Open Market Committee's (FOMC) statement following its December 2008 meeting, the committee announced that the target of the federal funds rate was likely to remain unchanged "for some time." This language was strengthened to "an extended period" in the March 2009 statement. An even more aggressive form of forward guidance was adopted in the August 2011 statement, when the FOMC specified that economic conditions warranted a best-case forecast of "exceptionally low levels of the federal funds rate until at least mid-2013," which was later extended to late 2014 and mid-2015, and turned into "a considerable time after the economic recovery strengthens" and "at least as long as

the unemployment rate remains above 6.5 percent" in its September and December 2012 statements, respectively.

It is interesting to note that the Fed has always been careful by offering federal funds rate forecasts, and not any explicit commitments. Each of these statements nevertheless resulted in significantly reduced forecasts for the federal funds rate by financial markets. For example, the December 2008 statement resulted in a 90-point decline in market expectations for the federal funds rate in the following year, while the August 2011 shift in communication had a 15-20 point impact on 10-year government bond yields, which was as big as a federal funds rate cut of 75-100 basis points in normal times (Williams 2012). In addition, the cost of credit for all kinds of borrowers, not just the U.S. Treasury, declined considerably. Overall, the Fed did manage to lower short-term interest rate expectations, and hence also long-term interest rates, through communication policies.

2.3. Outright Monetary Transactions (OMT) Program of the ECB

The ECB has always been more careful with its communications. Forward guidance only crossed the Atlantic in July 2013, when for the first time the Governing Council of the ECB announced in its press release after its monthly policy meeting that it expects the key interest rates "to remain at or below their current levels for an extended period of time." It is an open issue whether the ECB will use forward guidance more aggressively in the near future and whether it will become more concrete about the exact time frame over which interest rates will remain low.

A very effective ECB communication policy to bring down market interest rates faced by countries considered at risk to exit the euro has been its outright monetary transactions (OMT) program, announced in September 2012. The program is so aggressive that it has been called a "big bazooka." In particular, the ECB announced that it would buy short-term maturities in the secondary market from countries that have agreed to strict policy conditions in order to alleviate investor concerns about possible conversion into a local currency in case the euro collapses. A crucial element is that the size of the program is unlimited. Furthermore, the ECB dropped any asset seniority claims purchased under the program, which should assure investors that any purchases will not subordinate their own bond holdings.

As of the writing of this white paper, no country has yet applied for help under the OMT, but its very existence has greatly calmed financial markets by signaling that the ECB would, according to President Mario Draghi, do “whatever it takes to save the euro.” Following the ECB’s announcement of the program, government bond spreads within the eurozone

decreased considerably. Overall, the OMT program can be considered a game changer in the euro crisis. Interestingly, the risk that a government might renege on its promises after receiving help could imply that the OMT might work best as long as it remains inactive.

3. Central bank balance sheet policies

If overnight interest rates reach the zero lower bound, the central bank can also stimulate the economy by altering the composition of its balance sheet in order to change the relative supply of securities in the market, or by buying securities beyond the level required to hold the overnight rate at zero. The latter policy is known as quantitative easing and increases the sizes of both the central bank's balance sheet and the monetary base. A combination of both types of balance sheet policies is often classified as credit easing. These non-standard monetary policies may affect the economy through several possible channels.

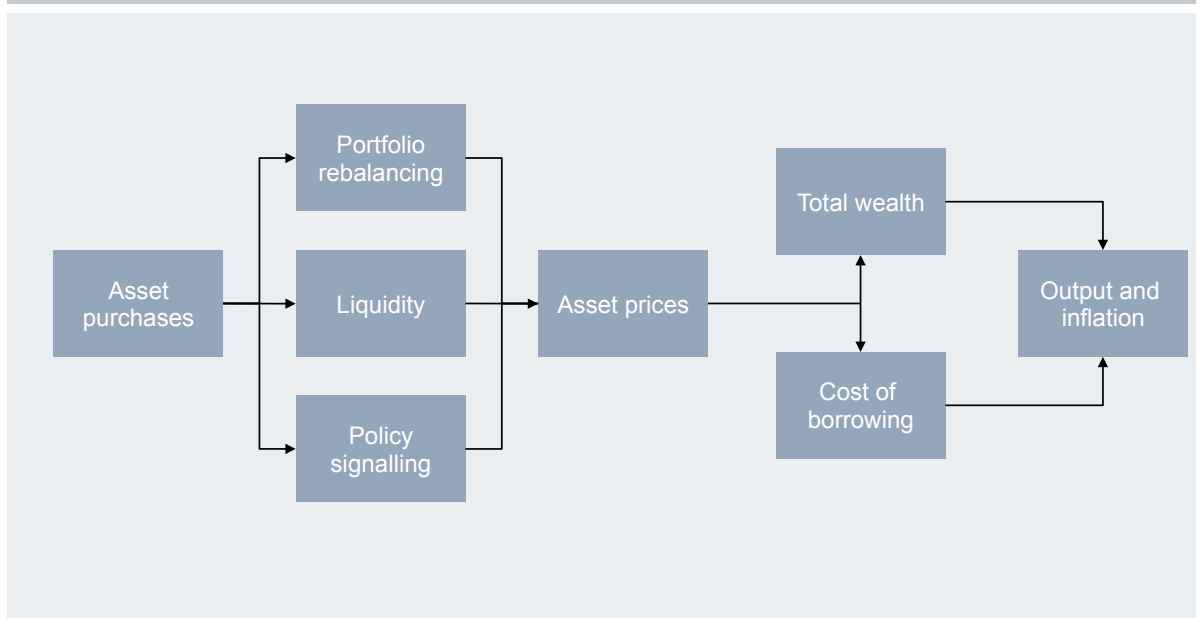
3.1. Transmission mechanisms

First, balance sheet measures can complement the central bank's communication policies as concrete action to signal intended future policies, which may be more credible than a simple verbal promise about future policy rates. It is, after all, costly to reverse large asset purchases very quickly due to the influence of such an operation on financial market yields and

profits of the central bank.

A second channel is the portfolio rebalancing effect created by the central bank's asset purchases, which may boost economic activity via longer-term interest rates and asset prices beyond changes in expected short-term interest rates. It is important to note that in a world of perfect financial markets, changes in the composition or size of the central bank's balance sheet when short-term interest rates hit the zero lower bound would have no effect on asset prices or the economy, because asset prices would then solely depend on expected future returns, adjusted for risk. If a central bank started to buy large amounts of a specific security, other investors would then simply sell their holdings and rebalance their portfolios with money or with securities sold by the central bank, whilst asset prices and long-term rates remained constant. As a consequence, a shift in the composition or an expansion of the central bank's balance sheet would have no effect on the broader economy, which would be essentially in a liquidity trap.

Figure 2. Transmission mechanism of central bank balance sheet policies



Source: Bowdler and Radia (2012)

However, if money or the securities sold by the central bank are an imperfect substitute for the assets that the central bank purchases, investors will instead rebalance their portfolios by buying assets that better substitute for the ones they have sold. For example, to match its long-term liabilities, a pension fund or insurance company might prefer long-term securities to money or short-term securities. These investors will purchase other long-dated assets, such as corporate bonds, to restore the so-called duration of their portfolios when the central bank starts buying long-term government bonds on a large scale. This will raise the prices and reduce the yields of these other assets, stimulating aggregate demand.

In general, from the moment that financial markets are incomplete or segmented, central banks are able to influence term, risk, and liquidity premiums – and thus the overall yields – by altering the relative supply of securities. The effectiveness of the portfolio-rebalancing channel will depend on the degree of substitutability between assets and the extent to which changes in the relative supply of specific assets have an impact

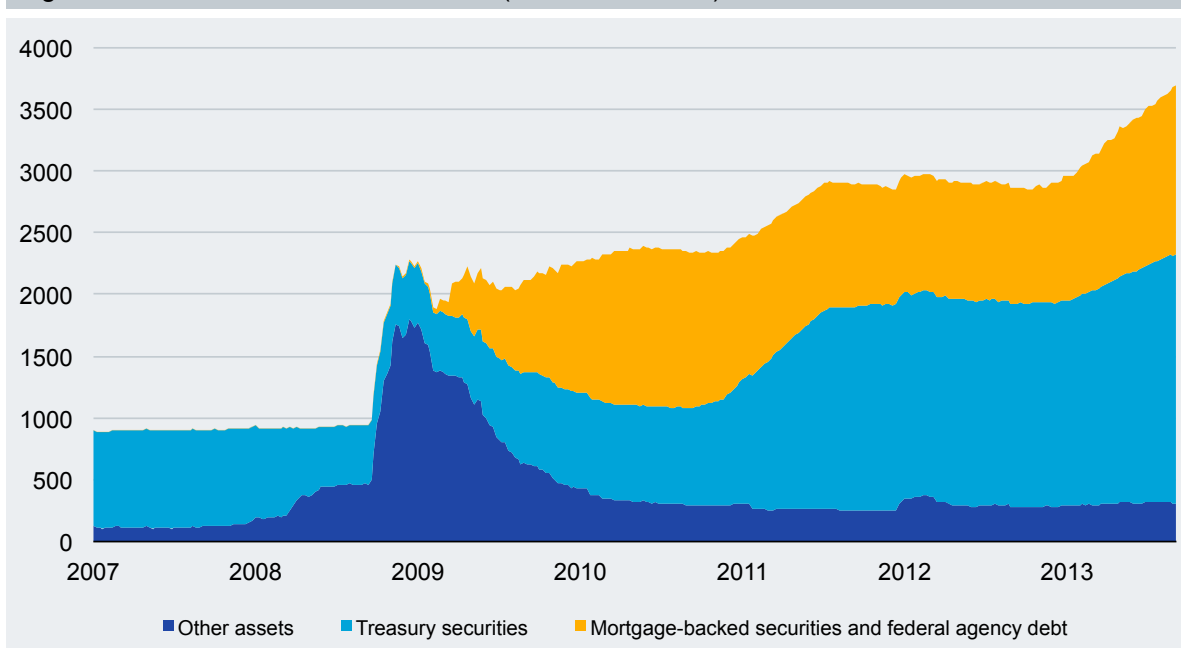
on absolute and relative returns.

Finally, if quantitative easing is sufficiently aggressive and long-lived, it could have expansionary fiscal policy effects. It is relevant that the government is the only shareholder that receives the profits of the central bank's money creation. When the central bank replaces public holdings of interest-bearing government debt with non-interest-bearing currency or bank reserves, the interest costs of the government must decline, further stimulating the economy.

3.2. The Fed's Large-Scale Asset-Purchase and Maturity Extension Programs

As can be seen in Figure 3, the balance sheet of the Fed has substantially increased since the collapse of Lehman Brothers, as a result of several Large-Scale Asset-Purchase Programs (LSAP) financed by the central bank. These programs are sometimes referred to as QE1, QE2, and QE3. In addition, the Fed also engaged in a maturity extension program (MEP), often called "Operation Twist."¹

Figure 3. Evolution of assets of the Fed (billions of dollars)



Source: Federal Reserve Board

¹Besides these programs, the Fed also provided temporary extraordinary liquidity for longer terms to banks, bought commercial paper and asset-backed commercial paper, and introduced measures to support money market mutual funds..

More specifically, the Fed launched the first LSAP (LSAP1 or QE1) in November 2008 and March 2009, with announced purchases of \$1.45 trillion of agency mortgage-backed securities (MBS) and agency debt, and \$300 billion of long-term Treasury securities. The program was completed in March 2010. The second round of asset purchases (LSAP2 or QE2) started in November 2010 with purchases of a further \$600 billion of longer-term Treasury securities over an eight-month period through June 2011.

Under the MEP, initiated in September 2011 and extended in June 2012, the Fed sold \$667 billion in shorter-term Treasury securities and used the proceeds to buy longer-term securities. Finally, in September 2012, the Fed launched LSAP3 (or QE3), which involves open-ended purchases of agency MBS at the rate of \$40 billion per month. In December 2012, this program was further expanded by purchases of \$45 billion in Treasury bonds per month. Overall, the balance sheet of the Fed more than tripled as a consequence of these programs. Notably, they have also resulted in a substantial increase in the degree to which the Fed holds longer-term securities on its balance sheet, rather than relatively short-dated Treasury bills.

Have these programs lowered long-term interest rates and other yields, on top of the announcement effects? There is a broad consensus in the literature that the asset purchases had economically significant effects, though there is disagreement about the exact magnitude of the effects. The empirical challenge is to isolate the contributions made by unconventional monetary policies, given the large number of other potential contributing factors.

Event studies, which assume that all changes in the variables of interest that occur within a short time period are due to the event under consideration, typically find substantial effects on the level of interest rates. Gagnon, Raskinb, Remacheb, and Sack (2011) find, for instance, that the cumulative impact of LSAP1 resulted in 91, 156, and 113-point declines in yields for 10-year Treasury securities, 10-year agency debts, and agency MBS, respectively. There was also a cumulative fall in the yields on Baa-rated corporate bonds by 67 basis points, indicating that the program had a broad-based effect on the cost of borrowing. On the other hand, econometric investigations tend to find somewhat smaller effects of LSAP1, which may be the result of a strong initial impact of the program's

announcement, which unwinds over time. The latter can be detected by econometric techniques, but not by event studies. In particular, studies based on regression analysis find an impact of LSAP1 on 10-year Treasury yields ranging between 20 and 80 basis points.

Empirical evidence further suggests that LSAP2 and MEP were less effective than the first program.² Estimates of the impact on 10-year government bond yields range between 20 and 55 basis points for LSAP2 and are approximately 20 basis points for MEP. A possible explanation is that the markets forecasted these programs and affected bond rates through anticipation effects.

A notable finding in the literature is that announcements of U.S. asset-purchase programs also had substantial effects on international long-term rates and the spot value of the U.S. dollar, suggesting that quantitative easing policies around the globe have important spillover effects. Finally, the existing empirical evidence suggests that massive expansion of the Fed's asset holdings was not associated with major concerns over rising inflation. In particular, inflation expectations remained relatively stable during the crisis and after the respective launches of the programs.

3.3. Full allotment strategy of the ECB and the demand for central bank money

In contrast to the Fed, the ECB has made outright asset purchases in limited volume. The ECB conducted two covered bond purchase programs between May 2009 and October 2012, which implied outright purchases of €76.4 billion in covered bonds issued by banks in the euro area. The aim was to revive liquidity in a market segment that had been an important source of funds for banks before the crisis. In addition, between May 2010 and the summer of 2012, the ECB intervened in the secondary markets of some euro area government bonds to ensure depth and liquidity, and to stabilise the ongoing euro crisis. Overall, the ECB bought €219.5 billion of government bonds.

According to the empirical literature, both asset-purchase programs have been successful in reducing interest rates. The outright purchases of long-term sovereign bonds (Securities Markets Program) have, for instance, lowered sovereign spreads in the periphery euro area countries by an amount ranging from

² Note that there is no evidence yet on the effectiveness of LSAP3.

35 basis points in Italy to 476 basis points in Greece (Szczerbowicz 2012). However, as can be seen in Figure 4, altogether they explain only around one-fifth of the overall increase of the ECB balance sheet since the start of the financial crisis. The remaining expansion is essentially demand-driven. It is the consequence of a switch in the ECB's strategy from liquidity provision to the banking sector towards a so-called full-allocation strategy.

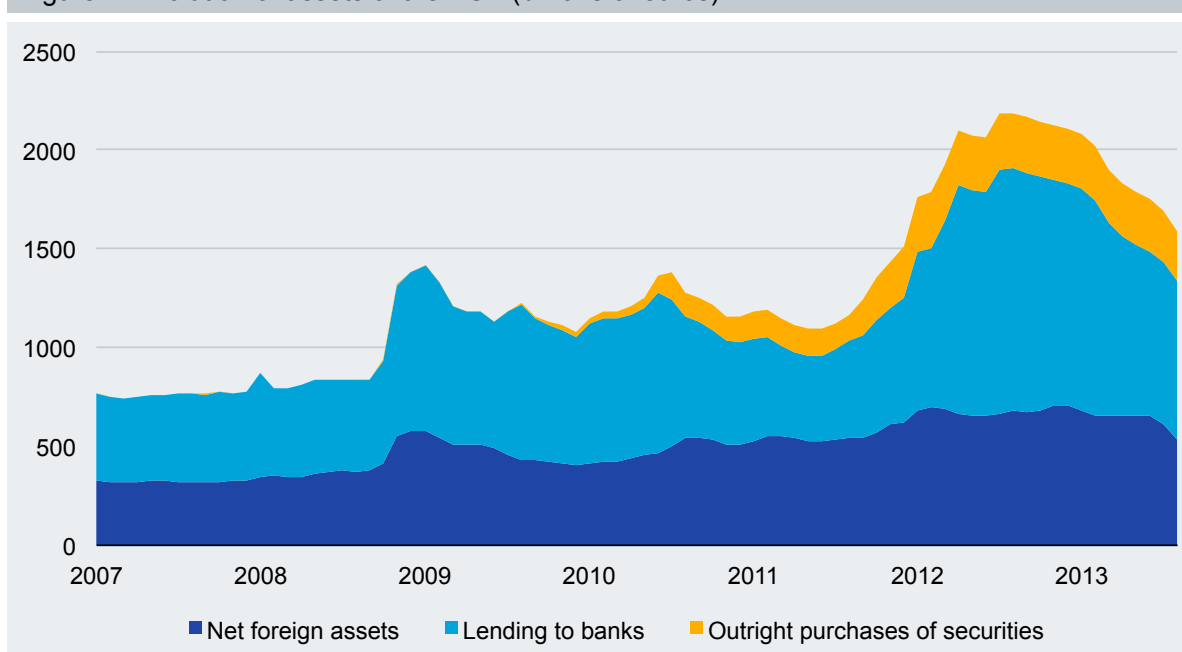
In the euro area, borrowing and lending predominantly take place via the banking sector, which is reflected in the way the ECB's monetary policy is typically implemented. More specifically, the ECB conducts its monetary policy by steering the overnight interbank rate (EONIA), which is the outcome of the interaction between the supply and demand for base money, as shown in Figure 5.

Due to its need for banknotes and the obligation to fulfill reserve requirements, the euro-area banking system has an aggregate liquidity deficit in normal times and is reliant on the

ECB for funding of the deficit. This is reflected in a downward sloping liquidity demand curve of the overall banking sector, as shown in the top left panel of Figure 5. Thus, the lower the interest rate, the higher the liquidity demand (e.g., because of the lower opportunity cost for holding cash money and excess reserves).

In a stable market environment, the ECB can estimate credit institutions' liquidity needs, and hence the demand curve for base money, relatively precisely. Accordingly, by virtue of its monopoly to supply base money, the ECB can steer the overnight interest rate by determining the liquidity supply to the banking sector. In normal times, this is organised via a standardised variable rate tender system, in which the ECB provides a pre-announced volume of liquidity corresponding to the estimated liquidity needs of the banking sector. In the next step, banks bid both the volume they wish to transact and the interest rate at which they want to enter into the transaction. The bids with the highest interest rates are satisfied first, followed by bids with lower rates, until the total amount

Figure 4. Evolution of assets of the ECB (billions of euros)



Source: European Central Bank

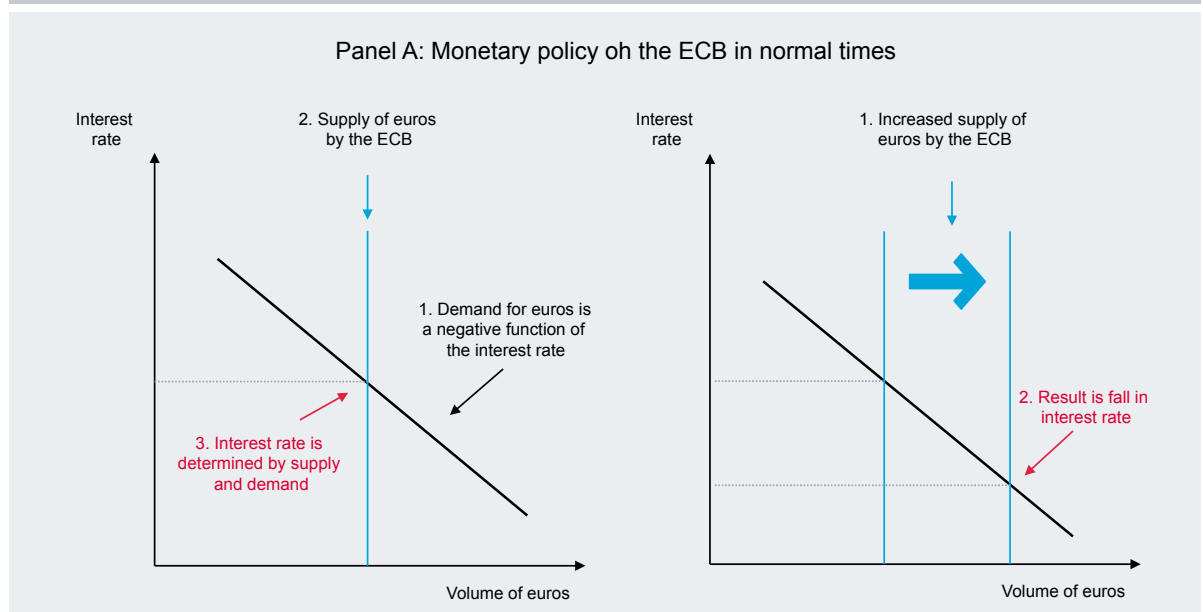
of liquidity to be provided is exhausted. Credit institutions can use the liquidity against assets pledged as collateral for a period that is usually one week (main refinancing operations) or three months (longer-term refinancing operations). For the main refinancing operations, the ECB announces a minimum bid rate in order to signal the interest rate target. When the ECB wants to lower interest rates, it simply increases the supply of base money in its tenders, as shown in the top-right panel of Figure 5.

The proper functioning and integration of the interbank market is vital in order to redistribute the liquidity from banks with a surplus to banks with a shortage. In normal times, this is not a problem. As a consequence of the financial crisis, however, banks started to have doubts about the financial health of their counterparts in the interbank market, while the uncertainty regarding the financial health of credit institutions resulted in a collapse of activity in many financial market segments. In addition, several banks started to build up large liquidity buffers. This all resulted in unpredictable fluctuations of the

banking sector's liquidity demands, which complicated the conventional implementation of monetary policy. If the ECB, for instance, underestimated the demand for liquidity, money market interest rates could rise considerably, as shown in the bottom-left panel of Figure 5. This would obviously damage economic activity.

To avoid serious fluctuations in money market interest rates and economic activity, the ECB started to conduct a fixed-rate, full-allotment strategy to provide liquidity to the banking sector after the collapse of Lehman Brothers. From October 2008 onwards, credit institutions have had unlimited access to liquidity from the ECB at a pre-specified interest rate set by the ECB, as long as they could provide the required collateral. This essentially means that the ECB has replaced as its policy instrument the supply of money with the interest rate. As can be seen in the bottom-right panel of Figure 5, the volume of liquidity distributed by the ECB to the banking sector is now fully endogenously determined by the demand for liquidity, which means that the ECB does not control the exact volume

Figure 5A. Consequences of full-allotment strategy of the ECB

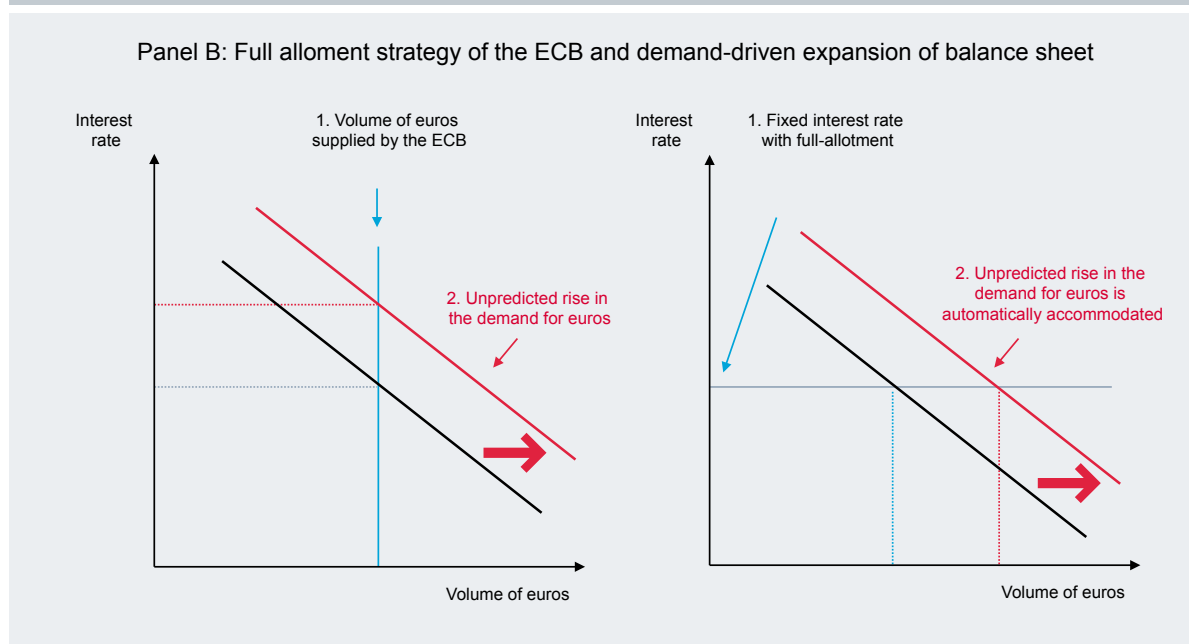


of base money in circulation anymore. When the demand for liquidity rises, there is an increase in the ECB's balance sheet. In sum, in contrast to the Fed, the bulk of the expansion of the ECB balance sheet since the start of the financial crisis has been essentially demand-driven and the consequence of a shortage of liquidity in the interbank market in combination with the full-allotment strategy.

Accordingly, in order to further ease monetary conditions beyond the overnight interest rate, the ECB has conducted some non-standard monetary policy measures to raise the demand for base money and hence the size of its balance sheet. The list of eligible collateral accepted in the refinancing operations has been extended several times, allowing

banks to refinance less liquid assets for money, raising liquidity demand from the banking sector. Such operations shift the demand curve for base money to the right, as shown in the bottom-right panel of Figure 5, increasing the volume of money in circulation. In addition, the maximum maturity of the longer-term refinancing operations was extended to 6 months in February 2009, then to 12 months in June 2009. There were even two refinancing operations with a maturity of 36 months in December 2011 and March 2012. In these two operations, banks borrowed more than €1 trillion. All these measures resulted in a considerable rise in the ECB's balance sheet due to the expansionary impact on the demand for base money. In the next section, we assess the macroeconomic effects of these policies.

Figure 5B. Consequences of full-allotment strategy of the ECB



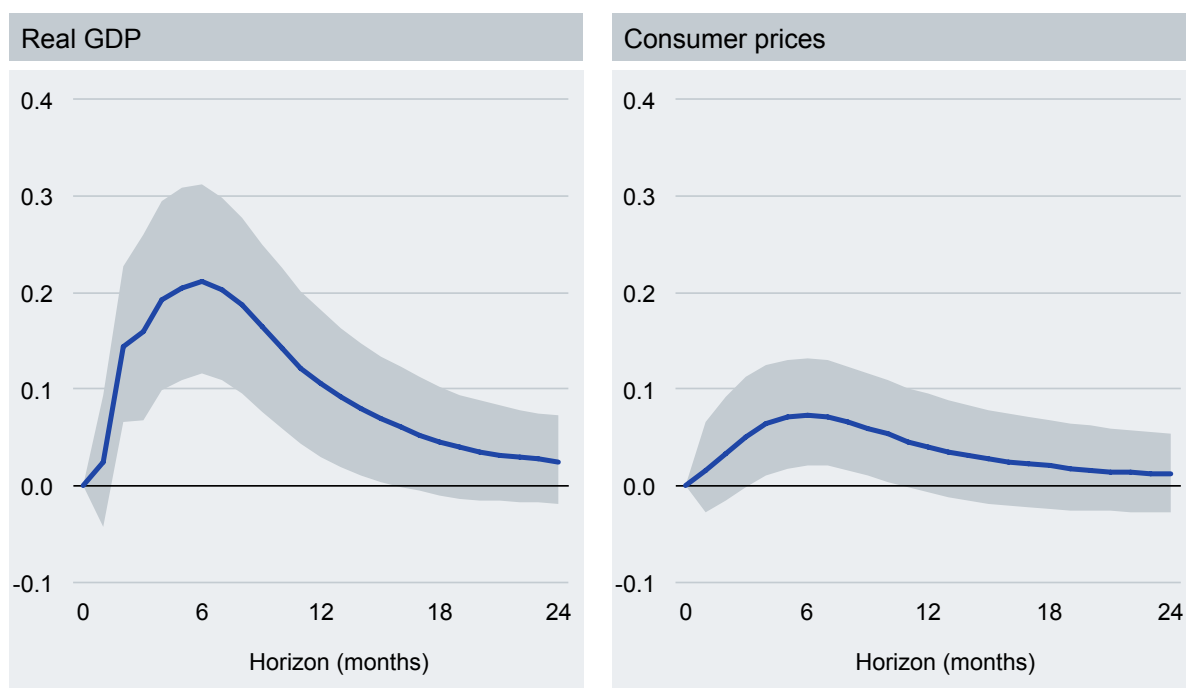
4. Macroeconomic effects of balance sheet policies

An extensive literature has already investigated the impact of conventional interest rate movements on real activity and inflation.³ However, little is known about the macroeconomic effects of non-standard policies and how they differ from conventional interest rate changes. Here I report the results of research that fills this gap.⁴ It is based on structural vector autoregressive (SVAR) models, which are estimated exclusively for the financial crisis period. An SVAR model is an econometric technique that is typically used to estimate the dynamic effects of fiscal and monetary policy innovations. VAR models are reduced form multivariate representations of a set of macroeconomic variables. By imposing a minimum set of parametric or sign restrictions, it is possible to identify the structural exogenous economic events (shocks) that drive the macroeconomic variables, such as expansions in

central bank balance sheets. Once the shocks are identified, the SVAR model allows us to study the dynamic responses of macroeconomic variables to these identified shocks, controlling for other potentially relevant changes in the economic environment.

The SVAR models have been estimated for a panel of eight advanced economies simultaneously: the United States, the euro area, Japan, the United Kingdom, Canada, Sweden, Norway, and Switzerland. Interestingly, it turns out that there are no significant cross-country differences in the macroeconomic effects of innovations to central bank balance sheets of a similar magnitude, despite the different measures that were taken in response to the crisis.

Figure 6. Impulse responses of real GDP and consumer prices to a 10% expansion in the central bank balance sheet



Source: Gambacorta, Hofmann, and Peersman (2013)

³ For instance Christiano, Eichenbaum, and Evans (1999) for the United States, and Peersman and Smets (2003) for the euro area.

⁴ Gambacorta, Hofmann, and Peersman (2013).

Figure 6 shows the average estimation results for the advanced economies. These are represented by so-called Impulse Response Functions (IRFs). More specifically, the figures show the dynamics over time of real GDP and consumer prices after a 10% rise in the balance sheet of the central bank at period 0, which subsequently returns to its baseline value. All other shocks in the economy are set to zero. The dotted (red) lines are the estimated impulse responses, while the shaded (light blue) areas represent statistical confidence bands, that is, the 16th and 84th percentiles of the estimated posterior distribution of the impulse response functions.

The dynamics of real GDP and consumer prices reveal that unconventional monetary policy measures were effective in supporting the macro-economy. Both macroeconomic variables display a significant increase after an expansion in the central bank balance sheet. Real GDP is found to rise with a peak effect after about six months and to return gradually, over approximately 18 months, to the value it would have been without the rise in the balance sheet. Compared to the existing evidence on the transmission of conventional monetary policy shocks that are associated with a change in the short-term interest rate, the response pattern of output turns out to be qualitatively very similar. The impact on consumer prices is, however, different. Specifically, the peak effect of a rise in the balance sheet on consumer prices coincides with that of the output response, while the impact of interest rate shocks on the price level is typically found to be very sluggish with a peak only after about two years or more.

When we compare the magnitudes of the effects, it appears that unconventional monetary policy shocks have larger outputs and smaller price effects than conventional monetary policy shocks. More precisely, the peak effect of an unconventional monetary policy shock on output is estimated to

be about three times larger than the peak effect on prices. In contrast, studies on the transmission of interest rate shocks usually find the effect of a monetary policy shock on output to be only about 1.5 times larger than the impact on price levels. One potential explanation for this weaker price level response could be that the unconventional monetary policy shocks were solely estimated over a recession or economic stagnation period. Specifically, several theories predict that the short-run aggregate supply curve is convex. Convexity implies that the slope of the supply curve is steeper at higher levels of economic activity and inflation than at lower levels. This can be due to the fact that, as the economy expands, more firms find it difficult to increase their capacity to produce in the short run. In such a situation, inflation becomes more sensitive to shifts in aggregate demand, including those driven by monetary policy, at higher rates of capacity utilisation, and the reverse occurs at the lower capacity utilisation rates that occur, for instance, in a recession period. This explanation is commonly brought forward to rationalise evidence showing that interest rate innovations generally have a larger effect on output and a smaller effect on price levels in recessions.

The results suggest that a doubling of balance sheets has an impact of approximately 2% on output. The latter is equivalent to a 300-basis-point cut in policy rates. In other words, unconventional monetary policy helped to mitigate certain macroeconomic effects of the crisis. Note, however, that this evidence does not imply that an expansion of central bank balance sheets will always have positive macroeconomic effects. The estimations solely apply to the crisis period, when unconventional monetary policy measures were actively used to counter financial and economic risk. The results therefore do not in general pertain to the possible effects of central bank balance sheet policy in non-crisis periods.

5. Exit strategy

Although the evidence shows that unconventional policy actions have been effective at stimulating economic growth, it is clear that there remains a great deal of uncertainty about the long-run effects of these policies. Given the uniqueness of several of the utilised measures, we do not know all the consequences. These policies may, for instance, contribute to excessive risk-taking in financial markets as investors seek higher yields in a low interest rate environment. Furthermore, the analysis does not capture potential negative side effects of prolonged monetary easing, as brought about by expanded central bank balance sheets in conjunction with low policy rates. These include delaying private and public sector balance sheet repair in the economies hit by the crisis and longer-term risks for central banks' credibility and operational autonomy.

An important concern is that the expansion of the central bank balance sheets may be building up inflationary pressure. So far, inflation has been very low during the period of unconventional policies, and inflation expectations also remain well-anchored. In the short to medium term, it is also unlikely that we will be confronted with sizeable inflationary pressures. Most of the liquidity that has been injected in the financial system is currently held as excess reserves by banks at their respective central bank. As a matter of fact, broad money aggregates did not increase significantly since the outbreak of the financial crisis. And given current economic conditions, there is no reason for prices to increase. Firms will only raise prices when demand is strong and production costs increase. Therefore, as long as the economy is below full capacity, there is no risk of inflation.

However, as the economy recovers and banks have more opportunities to lend out their reserves, the expansion of central bank balance sheets could result in easier credit conditions, faster growth in broad money aggregates, and ultimately an acceleration of inflation. The only way to avoid such a scenario is to adopt countervailing policy measures, either to eliminate the large reserve balances or to neutralise undesired effects on the economy. This is often called the "exit strategy" or "tapering" of unconventional monetary policy.

There are several ways to wind down the non-standard measures once conditions return to normal. First, a number of the available unconventional policies are of a temporary nature

and have built-in and self-correcting mechanisms. In particular, the demand-driven surge of liquidity in the euro area resulting from the ECB's full-allotment strategy will contract automatically, as improving financial conditions lead to a reduced use of lending facilities. As can be seen in Figure 4, this is already happening today. Part of the large-scale asset purchases will also phase out automatically when securities mature and are not renewed.

Second, the Fed and the ECB could increase reserve requirements. Specifically, both central banks require credit institutions to hold compulsory deposits on accounts at the central bank (in the U.S., vault cash is also taken into account). By increasing the required reserves, banks would not be able to use the money for borrowing. Hence, this part of money creation would not lead to inflation.

Third, both central banks could raise interest rates, in particular the rate paid on banks' excess reserve balances at the central bank. Banks will normally not lend funds in the money market at an interest rate lower than the rate they can earn at the central bank. In addition, they will compete for the liquidity offered in the market at rates below the interest rate on reserve balances offered by the central bank because they can earn a spread without risk by doing this. Accordingly, the money will be drained from the markets and will not be able to create inflationary pressure.

It is interesting to note that, due to the arbitrage by banks in money markets, the interest rate paid on excess reserves will put a floor under short-term market rates, including the overnight interest rate. Very likely, the interest rate paid on reserves, instead of the federal funds rate and the EONIA, could for a time become the most important indicator for conditions in money markets and a guide for the monetary policy stance. Furthermore, the Fed and the ECB could offer term deposits to banks, analogous to deposits that banks offer to their customers. Bank funds held in such term deposits are obviously not available for the money market. Similarly, they could absorb excess liquidity by organising large-scale reverse repurchase agreements with financial market participants. Reverse repurchase agreements involve the sale of securities by the central bank with an agreement to buy the securities back at a later date. Finally, both central banks could simply reverse the asset-purchase programs by selling a portion of their assets

⁵ Notice that the current debates on Fed tapering involve a reduction in the amount of new asset purchases, which is still not the sale of securities.

into the open market in exchange for liquidity. Each of these policies should help to limit the growth of broad measures of money and credit, thereby tightening monetary policy on top of the usual interest rate rises.

6. Investment conclusions

Based on the analysis in this white paper, we can conclude that the unconventional monetary policy measures of central banks were effective in stabilising financial markets, reducing (long-term) interest rates, and stimulating economic activity. At the moment, there are no risks to price stability. As long as economic activity is below its full-employment level, there is no reason for inflation to take off as a result of the abundant liquidity in circulation. Firms will only increase prices when demand is strong.

When the economy recovers, central banks will have to remove monetary stimulus by raising interest rates and shrinking their balance sheets in order to avoid high levels of inflation. In theory, there should be no obstacles to this course of action. As discussed, central banks have several tools to organise their exit strategy. In practice, however, several problems may emerge. Timing will obviously depend on evolving economic conditions, but the policy tightening is likely going to be too little, too late. As a consequence, inflation could be relatively high for a while once the economy has recovered. This may be higher consumer price inflation, strong asset inflation, or a combination of both. There are several reasons to expect such imperfect timing and reluctance for a policy tightening.

First, in contrast to conventional interest rate tightening, there is little historical experience to determine the optimal time to shrink the balance sheet of the central bank. A prompt withdrawal of non-standard measures and abundance of liquidity in the market could, for instance, distort the recovery and have undesired consequences on financial markets. The markets are currently already very nervous about such a scenario. This uncertainty suggests that balance sheet renormalisation will probably proceed cautiously, with asset sales only commencing some time after the first policy rate increase. This is in line with the Brainard (1967) principle of optimal policy under uncertainty: If a shift in a policy tool has uncertain effects, it should be employed more cautiously than a shift in policy tools that have more certain effects. Accordingly, the exit of unconventional monetary policies might start too late.

Also, a delayed policy tightening is inherently part of the Fed communication policies that have tried to shape interest rate expectations. In particular, abolishing the Fed's implicit commitment to keep interest rates low for a longer period than the financial market predicted could harm the Fed's credibility to

counter future recessions with forward guidance.

Second, central banks will be reluctant to shrink their balance sheets because it will harm economic activity. More specifically, as expansionary unconventional monetary policy shocks lead to a significant temporary rise in real GDP, as discussed in Section 4, the opposite is also true for the winding down of these measures. For instance, a reduction of the balance sheet by 50% will have a negative effect of approximately 2% on real GDP. There will be strong political pressure on central banks to avoid such output losses because they could trigger another recession.

Third, balance sheet renormalisation could lead to considerable losses on the central bank's securities portfolio because long-term interest rates will rise due to the large sales. At the margin, every dollar central banks lose is the taxpayers' money. This will lead to political pressure against asset sales. The same is true for paying high interest rates on bank reserves. As a result, central banks will be reluctant to tighten policy a lot, and will probably do less than required to keep inflation below target.

Fourth, policymakers do not mind higher inflation, in combination with low interest rates, for a relatively long period of time. Low nominal interest rates can help governments reduce their lending costs and a steady dose of inflation erodes the real value of government debt. A policy of negative or very low real interest rates is often called financial repression and can be considered a form of taxation. Given that deficit reduction usually involves unpopular tax increases and expenditure reductions, financial repression may be politically more attractive to reduce outstanding debts. In the end, high debt levels and leverage are important contributors to the ongoing worldwide slowdown in economic growth and higher unemployment. These symptoms are unlikely to disappear until the debt overhang problem is addressed. Higher inflation rates will contribute to debt normalisation.

In sum, despite the fact that central banks have the capability to reverse the surge of their balance sheets, it is unlikely that the rate and magnitude of their efforts will be sufficient to maintain price stability once the economy has recovered. Inflation rates can thus be expected to be higher for a significant period subsequently. For the euro area, this will first

be in the North, whose economies will return to full capacity sooner, resulting in upward pressures on wages and prices set by firms. In contrast, as long as Southern European countries have high unemployment and low capacity utilisation rates,

wages and prices in these countries will not rise significantly. Only when competitiveness within the euro area has been restored will inflation rates across countries converge.

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