

Monetary Policy in 2008 and Beyond*

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I. Introduction

The financial crisis that began in 2007 led to serious impairment of the functioning of financial markets worldwide and contributed significantly to the recession of 2008-2009 experienced by the world's major economies. Monetary policymakers responded initially in a conventional way by cutting interest rate targets and by making borrowing from existing lending facilities more attractive, but, as the crisis intensified and the recession deepened, monetary policy makers began to employ more unconventional tactics. The focus of this essay is a discussion of the monetary policy actions undertaken by major central banks during the crisis and some of the implications of the crisis for post-crisis monetary policy. However, before discussing the details of monetary policy responses, it will be instructive to discuss briefly how the effects of monetary policy are transmitted to the economy since this helps us understand the actions undertaken by central banks.

II. The Monetary Transmission Mechanism

In formulating and implementing monetary policy in normal times, monetary policymakers first specify a target for a short-term (often overnight) interest rate that they think is consistent with achievement of the ultimate goals of monetary policy—price stability (operationalized as a low rate of inflation) and stabilization of output (real GDP) around the natural level.¹ As discussed in more detail later, central banks are also concerned about financial market stability, but during most time periods, the focus is on price and output stabilization. The actual value of the policy rate is determined by the interaction of the demand for and supply of banking system reserves. Central banks vary the supply of reserves through open market operations (the purchase or sale of securities by the central bank) to try

¹ Even central banks whose mandated primary goal is price stability (the Bank of England and the European Central Bank, for example) are also concerned about stabilizing output. Given the relatively long lags from monetary policy actions to changes in prices, the mandate to achieve price stability is defined as achieving a low rate of inflation (usually in the range of 1%-3%) over the medium term (two or so year period). This medium-term focus for price stabilization gives these central banks scope to respond to movements of output away from the natural level in the short-run. Further, when the economy is hit by aggregate demand shocks, actions taken by central banks to stabilize prices will also contribute to the stabilization of output around the natural level.

to push the actual overnight rate to the target level. If the central bank wants to stimulate private sector spending, it cuts its target for the overnight rate and if it wants to restrain spending, it raises the target for the overnight rate. A problem for the central bank in influencing aggregate demand is that private sector spending depends on longer-term interest rates, but, in conventional monetary policy, the central bank directly influences only a very short-term interest rate. Since capital goods, consumer durable goods, and houses are long-lived assets, firms and consumers typically borrow longer-term to finance the purchase of these goods, and the relevant interest rate for these spending decisions is an intermediate-term or a long-term interest rate.

However, as described in the liquidity/term premium hypothesis of the term structure of interest rates, there is a systematic linkage between short-term and longer-term interest rates. This hypothesis suggests that, for bonds that differ only in term-to-maturity, a longer-term interest rate is an average of the current and expected future short-term interest rates over the term-to-maturity of the longer-term bond plus a liquidity/term premium that reflects the higher interest rate risk of the longer-term bond. Notice that if only the current short-term interest rate changed when the central bank changed policy, there would be minimal effects on the yields on longer-term bonds, especially bonds with many years to maturity. However, since central banks often adjust their target interest rate in relatively small steps and only infrequently rapidly reverse their decisions, a change in the current period target rate suggests that this change may persist for some time and/or there will be future changes in the target rate in the same direction as well. Thus, a change in the current short-term interest rate will likely affect expectations of future short-term interest rates and hence a change by the central bank in its target for the short-term rate can have significant effects on longer-term interest rates as well. Chung et al (2011) estimate that in the U.S. over the 1987-2007 period a 100 basis point (1% point) cut in the federal funds rate was associated with a 25 basis point (BP) decline in the yield on 10-year Treasury bonds.

Central banks may also try to facilitate the formation of accurate expectations about future short-term interest rates by providing conditional statements about the likely future path of the target rate (“forward-guidance”). As noted by Thornton (2010a), Federal Reserve statements about monetary policy actions began to formally incorporate forward-guidance in 2003, and during the financial crisis the Federal Reserve stated in discussions of policy actions that target rates would be maintained at a very low level for an extended period of time.

Thus, one way that monetary policy affects aggregate demand is by changing borrowing costs for firms and consumers as longer-term interest rates react to changes in the central bank’s target short-term rate. However, there are other channels through which monetary policy can affect spending. A decline in interest rates following an expansionary monetary policy action leads to depreciation of the domestic currency in foreign exchange markets as domestic and foreign investors shift away from domestic financial assets towards foreign assets whose yields are initially unchanged. The depreciation in the domestic currency in turn reduces domestic spending on imports and induces higher foreign spending on domestic goods. Net exports and hence aggregate spending on domestic production rise.

The decline in the yield on bonds following an expansionary monetary policy also induces investors to shift funds from bonds to other domestic assets—both financial and real. Thus, investors shift funds into stocks and into real assets like houses and land, and their prices rise. The value of stocks, homeowner equity, and the value of land constitute important components of private sector wealth, and changes in wealth lead to changes in consumption in the same direction. Increases in stock prices can also affect investment spending by firms. Stocks represent ownership in a company and hence a claim on a company’s capital stock. An increase in stock prices indicates that the market’s valuation of the capital stock of companies has risen, and this can induce firms to purchase more capital

goods. In addition to raising private sector wealth, increases in house prices tend to induce contractors to increase construction of new homes, a component of aggregate investment spending.

The monetary policy channels discussed above are often called asset-price channels, but there are also credit channels through which monetary policy may operate. The focus in the credit channels is on lenders ability and willingness to supply funds to borrowers. One channel, the bank-lending channel, is premised on the fact that banks are important sources of lending to individuals and to small and medium size firms that often don't have access to bond markets. In Europe, banks are even more important as sources of funds to firms than is the case in the U.S. ECB (2010) reports that for the 2004-08 period, bank financing was about 75% of the external financing of non-financial corporations but was less than 50% in the U.S. Since monetary policymakers adjust the supply of reserves to change short-term interest rates, and since changes in reserves affect banks' ability to extend loans, changes in monetary policy may be associated with changes in the supply of loans to borrowers who borrow mainly from banks, and this in turn may have effects on the spending of these bank-constrained borrowers. However, this channel is controversial and empirical evidence on the strength of this channel is mixed.²

A second credit channel is called the balance sheet channel, and the essence of this channel is the effect of a borrowing firm's net worth on the willingness of lenders to lend. Other things equal, lenders are more willing to lend to firms with high net worth than firms with low net worth. By affecting stock prices and hence the market valuation of the capital of firms, monetary policy can affect firms' net worth and the willingness of lenders to lend. Note another implication of this channel: non-monetary policy disruptions to financial markets that reduce asset prices can influence the net worth of

²Critics have argued that reserves aren't the only source of funds for banks to use to make loans; banks can adjust their managed liabilities (which include short-term borrowings from other banks, the use of repurchase agreements, and issuance of time deposits) to obtain funds to lend. Thus, if a central bank drains reserves from the banking system, banks might increase their managed liabilities in order to avoid reducing loans.

firms and hence the willingness of lenders to lend. For a more detailed discussion of the channels through which monetary policy operates, see Mishkin (1995).

The discussion in this section suggests that financial markets and the prices and yields that are determined in these markets are important in transmitting the effects of monetary policy to the rest of the economy. It follows that disruptions to financial markets interfere with the ability of monetary policy makers to affect spending and hence to achieve the ultimate goals of monetary policy. This is one reason monetary policymakers are very concerned about dysfunctional financial markets—their actions are less effective when financial markets are not functioning smoothly. At a very fundamental level, financial markets serve to transfer funds from savers to borrowers, thereby allowing firms to purchase capital goods that add to the economy's productive capacity and individuals to better time major purchases like purchases of houses or consumer durables. Dysfunctional financial markets thus interfere with the efficient allocation of funds within the economy, and this is another reason that central banks have historically been concerned about financial market stability.

One of the ways that central banks try to insure financial market stability is by serving as the “lender of last resort” which means the central bank is the ultimate supplier of liquidity to financial institutions. A second way in which many, but not all, central banks try to insure financial market stability is through regulation and supervision of financial institutions. Before the financial crisis, the Federal Reserve shared regulatory responsibility with several other regulatory agencies; in the Eurosystem, regulation was primarily the function of the national central banks rather than the European Central Bank; and in Great Britain, regulation was the province of a government agency separate from the Bank of England. Most of the regulation and supervision in the past was micro-prudential in nature; the focus was on the safety and soundness of individual institutions with relatively

less regard for the implications of the interconnections among institutions for the system as a whole.³

The recent crisis has stimulated discussion of macro-prudential regulation and the role of central banks in the regulatory process. This latter issue will be discussed briefly later.

Typically central banks have acted as the lender of last resort to prevent or stop “runs” on banks in which many customers become fearful of the solvency of a bank and try to convert deposits into currency at the same time. Deposits are a critical source of funding for banks, and the loss of deposits greater in volume than the reserves held by the bank means that the bank will have to scramble for funds from other sources or begin selling assets, perhaps at “fire sale” prices, in order to meet its customers’ currency demands. The fear of insolvency can lead to the actual insolvency of the bank even if there was no real cause for concern before the run began. A central bank can often stop a bank run by supplying reserves to solvent but illiquid banks thus enabling them to meet customer currency withdrawal demands and thereby reassure other customers that their deposits are safe. Under the Bagehot rule for a lender of last resort, a central bank would loan reserves at a penalty rate (a rate higher than banks could borrow at in the market) to solvent banks that can pledge high-quality collateral and that are under pressure and losing reserves.

Although there wasn’t a run on traditional banks during the crisis, the collapse of the housing bubble, the rise in defaults on mortgages and fall in the price of mortgage-backed securities (MBS)—widely held by both bank and non-bank institutions like investment banks and hedge funds—led to a decline in the value of assets held by many financial institutions and hence a deterioration in their balance sheets. A shared characteristic of banks and many non-bank institutions like investment banks and hedge funds is that they borrow short-term but invest in longer-term assets; indeed, for this reason,

³Central banks play an important role in the payments system of the economy, and, as a key player in the payments system, central banks were well aware of systemic risk that could be generated by the failure of say, two banks, to settle a payment on the ability of other banks to settle transactions. A criticism of central banks that had a regulatory and supervisory function was that they did not sufficiently scrutinize the interconnections among the balance sheets of financial institutions and the riskiness of the assets held.

non-bank institutions like investment banks and hedge funds are often called “shadow banks”. Financial institutions that relied in part on short-term financing like commercial paper (CP) for funding found it difficult to sell CP, and institutions that relied heavily on repurchase agreements for funding also found it difficult to roll over their repurchase agreements. Lenders were concerned about the solvency of many of these institutions and were not willing to lend on the same terms as before or even to lend to these institutions at all.⁴ As a result, many financial institutions had serious liquidity problems, and many were forced to quickly sell some of their assets at “fire-sale” prices, reducing asset prices further and leading to further deterioration in financial institution balance sheets.

Financial institutions thus had serious concerns and uncertainty about the quality of their own balance sheets and those of other financial institutions, and lending among financial institutions dropped. Financial institutions began to curtail lending to customers and the availability of credit to both individuals and firms fell. There was a “flight to quality” by many investors, and spreads between yields on corporate bonds (both AAA and lower-rated bonds) and those on U.S. Treasury securities widened significantly, thereby raising borrowing costs for firms that could issue bonds. Because MBS were held by foreign as well as domestic financial institutions and because of the globalization of financial markets in general, the problems in U.S. financial markets were transmitted worldwide.

The decline in house prices and turmoil in financial markets was accompanied by a sharp decline in stock prices. In turn, the significant decline in house and stock prices and disruption to lending led to decreases in both consumption and investment spending. The U.S. economy was the first to move into recession, but as the effects of reduced economic activity in the U.S. and turmoil in financial markets was transmitted abroad, economic activity in other major economies declined. Central banks responded to recession and the liquidity crunch by cutting targets for policy rates and injecting large volumes of

⁴This withdrawal of funding from shadow banks is akin to depositors converting their deposits to currency in a bank run and hence this phenomenon is referred to as a run on shadow banks.

liquidity into the economy. We now turn to a more detailed discussion of the specific actions of the major central banks.

III. Central Bank Response

Central banks have several policy tools—open market operations, changes in the interest rate at which central banks lend to banks, changes in the interest rate that central banks pay on reserves, and reserve requirement changes. The latter is rarely used for a variety of reasons, and the most frequently employed tool is open market operations, the purchase and sale of securities by the central bank. As noted earlier, central banks establish a target for their policy rate and use open market operations to vary the volume of reserves in order to achieve that target. When a purchase is made from the public, the central bank credits the reserve account at the central bank of the seller's (counterparty's) bank, thereby increasing banking system reserves. The opposite happens when the central bank sells securities to the public.⁵ Most open market operations involve repurchase agreements (repos) and reverse repurchase agreements (reverse repos) and hence result in temporary changes in reserves. In a repo, the central bank buys securities from a counterparty with the agreement that it will sell the securities back to the counterparty at a specified price after a specified period of time, usually a very short period of time, and banking system reserves rise. In essence the repo is a short-term loan to the counterparty. In a reverse repo, the central bank sells securities to its counterparty with the agreement that the central bank will buy the securities back from the counterparty at a specified price in a specified period of time, and banking system reserves fall. When a central bank wants to change the volume of reserves for an extended period of time, it may engage in outright purchases or sales, i.e. transactions with no agreement to reverse the initial transaction.

⁵The seller or purchaser may be a bank or a customer of a bank like a security dealer.

Central banks typically also have standing facilities—a lending facility at which banks can borrow from the central bank and a deposit facility at which banks can earn interest on their reserves. The interest rate charged for borrowing is a penalty rate (i.e. it is a mark-up on the target for the policy rate) and the borrowing bank must pledge collateral to obtain the loan, usually high-quality collateral. The interest rate paid on reserves at the deposit facility is typically a “mark-down” from the target policy rate so the interest rate earned at the deposit facility is less than the target policy rate. These standing facilities serve as upper and lower limits on the actual value of the policy rate which, as noted earlier, is determined by the interaction of the demand for, and supply of, reserves, and hence these facilities help limit the fluctuations in the actual value of the policy rate. A bank wouldn’t typically borrow reserves from another bank at a rate greater than the central bank’s lending rate, and a bank wouldn’t typically loan reserves to another bank at a rate less than the rate that could be earned at the deposit facility. Since the standing facility rates are tied to the target for the policy rate, when the policy rate target is changed, so are the standing facility rates. Note that a reduction in spread between the lending rate and the policy rate target would tend to encourage banks to borrow more from the central bank. Payment of interest on reserves allows the central bank to change the actual policy rate when the volume of reserves in the system is sufficiently large relative to the demand for reserves so that the equilibrium policy rate equals the interest rate on reserves. In this case, if the central bank wanted to raise the policy rate, it could raise the interest rate on reserves and the actual policy rate would follow.

Prior to the crisis, the European Central Bank (ECB) and the Bank of England (BoE) had both lending and deposit facilities, but the Federal Reserve (Fed) had only a lending facility. However, legislation passed in 2006 authorized the Fed to begin paying interest on reserves in Oct. 2011, and legislation passed in 2008 moved up the payment of interest to Oct. 2008.

As the financial crisis began to unfold and economies moved toward recession, central banks reacted in their normal way and cut their policy rate targets (and hence the rates at their standing facilities) in a series of steps. As suggested earlier, this was designed to stimulate spending by reducing interest rates—both short- and long-term rates, depreciating the currency, and raising asset prices. As the crisis progressed and financial institutions' demand for liquidity rose, central banks responded by supplying more liquidity to the financial system in both standard and innovative ways.

The central bank policy innovations can be broadly categorized as credit easing and quantitative easing policies. In a pure form, credit easing involves changing the composition of the central bank's balance sheet without expanding its size. More conventional assets like holdings of short-term Treasury securities and short-term loans to banks are replaced with more unconventional assets like longer-term loans to banks and other financial institutions, longer-term securities, and non-Treasury securities to include private securities. The goal is to enhance the operation of financial markets by increasing liquidity and providing support to particular markets and particular types of financial institutions by changing the mix of assets held by the central bank. Of course, this also increases the risk faced by the central bank—interest rate risk rises as the share of longer-term securities held increases and default risk rises as the share of private securities rises. In pure credit easing, the effect on reserves of increased loans to financial institutions or the purchase of non-traditional securities is sterilized (offset) by open market sales of the traditional securities held or by reducing short-term loans while expanding longer term loans.

In its pure form, quantitative easing (QE) refers to a policy of expanding the size of the balance sheet without changing its composition, and this is achieved by increasing the volume of open market purchases. This leads to concomitant increases of banking system reserves and the monetary base. What effects might QE have? As just noted, reserves and the monetary base rise significantly, and this

could lead to a significant increase in the money supply if banks use the additional reserves to expand loans and/or buy securities. At the initial spectrum of yields on financial assets, an increase in the money supply creates an excess supply of money for the public, and the public would use these excess money balances to purchase other assets—both financial and real, thereby bidding up their prices and reducing their yields. Will QE be effective if the money supply doesn't change? Although the QE employed by central banks in the current crisis has significantly raised reserves and the monetary base, most of these additional reserves have been held as excess reserves and the money supply has risen by much a much smaller percentage than have total reserves and the monetary base. There are several explanations for this including a recession-induced reduction in the demand for loans, the payment of interest on reserves, an increase in banks' perception of the riskiness of loans due to the recession, and uncertainty about the specifics of increased capital and leverage regulation that will be imposed as a result of the crisis.⁶

Joyce et al (2010) discuss several ways QE might be effective in reducing yields and raising asset prices even if the money supply does not rise significantly, and these channels provide the rationale for the QE engaged in by the Fed and the BoE. Joyce et al note that QE is likely to be implemented when the policy rate is essentially at the zero-lower bound and the economy is mired in recession. In this environment, announcement and implementation of QE might provide information about the central bank's views on the state of the economy and future monetary policy (*macro-policy news channel*). In particular, QE may serve as a signal that the central bank thinks economic activity will be depressed for a good while and that the policy rate will remain at a low level for an extended period of time, thereby reducing expectations of the level of future short-term interest rates and hence reducing long-term

⁶Martin, McAndrews, and Skeie (2011) develop a model of the banking system in which interest is paid on reserves and there are no binding reserve requirements and bank loans are independent of the quantity of reserves.

interest rates. This effect should persist until it is announced that QE will be unwound (i.e. the securities purchased under QE are begun to be sold).

A second channel is the *portfolio rebalancing channel* which is based on the assumption that financial assets are imperfect substitutes, perhaps because investors might have preferred maturities for their investments (i.e. preferred habitats).⁷ Since short-term rates are very likely to be close to zero when QE is begun, QE is likely to be implemented through the purchase of longer-term bonds which, by significantly reducing the supply of long-term bonds to the public, should reduce yields on these bonds and thereby trigger a shift by investors into other assets like stocks or real assets. Since the price of an asset adjusts so that the quantity of that asset demanded equals the outstanding stock of that asset, this channel will persist until QE begins to be unwound.

A third possible channel might be labeled the *liquidity premium channel*. Other things equal, the more liquid an asset, the lower is its yield. In a financial crisis when many financial markets are dysfunctional, trading in a variety of assets falls and, consequently, the liquidity of these assets is reduced and their yields tend to rise (liquidity premium rises). If the central bank becomes a significant buyer in the market for an asset, market functioning improves, and the liquidity premium falls as does the yield. Note that unlike the first two channels, this channel is operative only as long as the central bank is actively purchasing the security. Once QE purchases end, this effect on interest rate disappears even though the earlier security purchases aren't unwound.

Finally, there might be a *macro risk premium* channel for QE. If QE is expected to help stabilize macroeconomic activity at normal levels, the risk of bankruptcy would be expected to fall as would the risk premium on securities issued by firms. This would in turn reduce the level of interest rates.

⁷For example, institutional investors like insurance companies might have a preference for long-term bonds in light of the long-term nature of many of their liabilities.

Thus, QE may be effective in reducing longer-term interest rates and raising the prices of stocks and other assets even if the money supply doesn't rise significantly.

Prior to Sept. 2008, when turmoil in financial markets increased substantially, the innovative central bank policies can be characterized as mainly credit easing policies. After Sept. 2008, the innovative policies are best characterized as a blend of credit and quantitative easing policies, especially for the Fed and BoE. There were a number of significant disruptions to financial markets in Sept. 2008, including the failure of the investment banking firm Lehman Brothers.⁸ The crisis deepened after Sept. 2008, and, as the turmoil in financial markets increased, interbank loans fell significantly, and the demand for liquidity rose substantially. We now turn to a discussion of central bank actions during the crisis; more details are presented in the appendix.

Figure 1 plots the policy rate targets for the Fed, the ECB, and the BoE from Jan. 2007 until April 2011. The first vertical line marks the month of August 2007, the beginning of the crisis, and the second vertical line marks the month of Sept. 2008 when turmoil in financial markets increased substantially. We note that these three central banks all reduced their target interest rates substantially. The Fed reduced its target for the fed funds rate in Sept. 2007 as a preemptory move to counter the expected future effects of the financial crisis on the economy. As the financial crisis worsened and the economy

⁸ On Sept. 7, in light of losses on MBS, Fannie Mae and Freddie Mac were put into conservatorship by the government. On Sept. 15, the Fed allowed the investment banking firm of Lehman Brothers to fail after efforts by the Fed and the Treasury to find a merger partner for Lehman came to naught. In March 2008, the Fed facilitated the takeover of the investment bank Bear Stearns by J.P. Morgan Chase through a loan to J.P. Morgan Chase, and, consequently, many participants in financial markets expected Fed assistance to prevent the failure of other large investment banks. Financial markets were surprised by the Fed's decision to let Lehman Brothers fail, and many observers believe this was the trigger for worsening of the crisis. On Sept. 16, the Fed made an emergency loan to AIG so that AIG could make payments on credit default swaps it had issued in large volume. Also on the 16th, the net asset value of shares of a large money market mutual fund fell below \$1. On Sept. 20, the U.S. Treasury submitted legislation to Congress to purchase "troubled" assets of financial institutions (TARP), and on Sept. 29, the House rejected the Treasury's proposed legislation, although it was later passed in October. Taylor (2009) argues that the trigger for the worsening of the crisis was the testimony of Federal Reserve Board Chairman Bernanke and Secretary of the Treasury Henry Paulson about TARP in Congressional hearings. He contends that this testimony created the impression that the crisis was much worse than previously believed and that it raised uncertainty about government intervention to mitigate the crisis.

moved into recession, the Fed continued to aggressively cut its target funds rate until it established a target range of 0%-0.25% in Dec. 2008. The BoE raised its policy rate target twice in 2007 because of concerns about inflation, but it began cutting its policy rate target in Dec. 2007 and over time reduced its target rate to 0.5% in March 2009. The ECB did not change its target rate until July 2008 when it raised it in response to rising inflation stemming from adverse supply shocks. The ECB's first cut in the policy rate came as part of the unprecedented coordinated cut in policy rates in Oct. 2008 by a number of central banks including the Fed and the BoE. Thereafter the ECB continued to reduce its policy rate until it hit 1% in April 2009. As these central banks cut their policy rate targets, following normal procedure, they also reduced the rates on their standing facilities. It can be argued that all three central banks essentially reduced their policy rate targets to the zero lower bound during the crisis. Although the ECB reduced its target rate only to 1%, effectively it had hit the zero lower bound as well since it allowed the rate on overnight lending among banks (the EONIA rate) to fall to the rate paid on deposits (0.25%).

In addition to cutting the fed funds rate target, the Fed also tried to manage market expectations about future values of the fed funds rate and hence maximize the effects of its policy rate cuts on long-term interest rates by adding language to its policy statements that the funds rate would be held at exceptionally low levels for an extended period of time. Neither the ECB nor the BoE used this type of explicit language to try to directly manage expectations of future values of the policy rate; both indicated they preferred the public to draw their own inferences about future values of the policy rate from central bank communications about policy actions and forecasts of economic activity.

As noted earlier, as the crisis progressed and the demand for liquidity grew, central banks provided substantial amounts of liquidity in both standard and innovative ways. In essence central banks substituted liquidity provision by them for the intermediation among firms that took place in

normally operating markets. The Fed was the most innovative in terms of new policy actions and set up a number of new facilities to supplement its regular liquidity-providing facilities. For the most part, the innovative actions of the ECB and the BoE took place within their normal frameworks for monetary policy. As noted by Lenza et al (2010), compared to the ECB, before the crisis the Fed dealt with a smaller number of counterparties (around 20 primary security dealers) than did the ECB (who regularly dealt with 300 counterparties with 2000 financial institutions eligible to participate in repurchase agreements). Pre-crisis, the same was also true for the BoE relative to the ECB. The collateral that could be pledged for borrowing and for repos was more limited for the Fed and the BoE who accepted government securities as collateral than for the ECB which also accepted asset-backed securities as collateral. The new Fed facilities allowed the Fed to deal with a broader range of counterparties and to accept a wider range of collateral than before the crisis. Further, as Bean (2011) notes, relative to the BoE, the broader range of new facilities of the Fed also reflects the greater variety of non-bank financial institutions in the U.S. compared to the U.K.

We now outline in broad fashion the actions of the central banks to provide liquidity to the system. We start with the Fed. As noted earlier, the Fed cut the rate it charged for borrowing (primary credit rate) at its lending facility (discount window). To encourage borrowing, it also reduced the spread between the primary credit rate and the target fed funds rate and lengthened the maturity of discount window loans from overnight to 30 days and then to 90 days. To further encourage borrowing by reducing the stigma associated with borrowing from the discount window, the Fed introduced a temporary lending facility which auctioned funds to banks for 28 or 84 days. The competitively determined rate at this facility was typically below the primary credit rate. Under authority granted in section 13(3) of the Federal Reserve Act, the Fed extended lending beyond banks to other financial market participants. Section 13(3) allows the Fed, in unusual and exigent circumstances, to lend to individuals, partnerships, and corporations that are unable to obtain adequate credit. The Fed set up

two facilities to make loans to primary government security dealers, critical middlemen in the normal functioning of financial markets in the U.S. One facility provided discount window-type loans to these dealers against a wider range of collateral than can be pledged at the discount window, and the other loaned U.S. Treasury securities to the dealers in exchange for less liquid federal agency securities and MBS. Since the CP market was severely disrupted in the financial crisis, the Fed set up 3 facilities to enhance the functioning of this market, but only two were used. One facility provided funds to banks to purchase CP from money market mutual funds thereby allowing the mutual funds to continue to play their critical role in purchasing newly issued CP. In the second facility, the Fed, through a special purpose vehicle, purchased newly issued CP from the issuer. The Fed also provided support to the asset-backed securities market through a facility in which the Fed extended loans to holders of newly or recently issued asset-backed securities. The Fed also used its emergency authority to provide support to specific firms—a legal entity set up by the Fed used funds loaned to it by the Fed to buy subprime-related assets from Bear Stearns to facilitate the merger of Bear Stearns and JP Morgan Chase and legal entities set up by the Fed provided secured funding to the insurance company AIG that was in danger of failing due to MBS-related credit derivatives. The Fed also engaged in currency swaps with other central banks in which dollars were provided in exchange for other currencies so that the other central banks could make dollar-denominated loans to banks in their countries.

Thus, the Fed increased the number of counterparties and the range of collateral accepted for loans, and the risk carried on the Fed's balance sheet rose substantially. However, Fleming and Klagge (2011) note that the net earnings to the Fed from the new facilities was about \$13b over the 2007-09 period and that thus far there had been no credit losses on the new facilities. Casual empiricism suggests these facilities contributed to the stabilization of financial markets and the reduction in liquidity premiums on financial instruments, but, as it now stands, there are relatively few formal studies of the effects of these facilities. For example, there is mixed evidence regarding the effectiveness of the

auction facility for loans from the Fed. McAndrews, Sarkar, and Wang (2008) and Christensen, Lopez, and Rudebusch (2009) find a significant effect on the liquidity premium whereas Taylor and Williams (2009) and Thornton (2010b) find no effect. Campbell et al (2011) find that the securities loan facility improved overall conditions in the market for asset backed securities, and Duygan-Bump et al (2010) find that one of the CP-related facilities significantly reduced the outflow of funds from money market mutual funds that held a high share of securities eligible for this facility.

As noted earlier, the ECB conducts its operations with a broad range of counterparties and accepts a broad range of collateral; consequently, it did not need to innovate to the extent that the Fed did. As it cut its policy rate target, the ECB also reduced the spread between its lending rate and the policy rate target as an inducement for banks to borrow. Upon inception of the crisis in August 2007, the ECB allowed banks to obtain as much overnight liquidity as desired at the then prevailing target policy rate through the execution of repos. Subsequently, it introduced supplemental repos with terms of 3 and 6 months while simultaneously reducing the volume of repos with shorter terms to maturity. During 2007, most of the liquidity provided came from repos rather than from its lending facility, and this remained true throughout the crisis. The range of counterparties was extended, and in Dec. 2007, the ECB engaged in currency swaps with the Fed. Beginning in Oct. 2008, the ECB introduced “enhanced credit support”. The ECB allowed financial institutions to obtain the full amount of liquidity they wanted at the policy rate, broadened the range of collateral including less liquid assets accepted for repos, and further extended the list of counterparties. The ECB also expressed intent to provide more funding through 6-month maturity repos and later introduced repos with 1 year maturity. In May 2009, it announced its intent to purchase €60b in covered bonds in order to help restore functioning in this important market. Again, casual empiricism suggests that these efforts were important in stabilizing financial markets (interest rate spreads fell and stock and bond markets improved), but there are relatively few formal studies yet. However, Lenza et al (2010) find empirical evidence that the enhanced

credit support policy had substantial effects on interest rates and loans and, with a delayed effect, on real economic activity. They also examined the effects of unconventional policy by the Fed and the BoE and found that these policies were also stabilizing.

The BoE also greatly extended its provision of liquidity to the system. As did the Fed and the ECB, it cut the spread between its lending rate and its policy rate target as an inducement to borrow from the BoE. In Dec. 2007, the BoE began to offer a larger volume of extended term repos and broadened the range of collateral for these repos to include residential MBS and covered bonds. Later the collateral was further broadened to include commercial MBS and corporate bonds. The BoE also established a currency swap facility with the Fed and established a temporary facility to allow banks to exchange temporarily illiquid MBS and other securities for U.K. government t-bills, which enhanced the liquidity of the borrower's balance sheet. In Oct. 2008, the BoE established a permanent facility with the same function as the temporary facility. The BoE also expanded the range of its counterparties to include a larger set of banks. As before, casual empiricism suggests these liquidity supplying efforts helped stabilize financial markets.

Figure 2 plots the evolution of these central bank's balance sheets as measured by the volume of assets from Jan. 2007-Apr. 2011. The size of each balance sheet is normalized to be 1 in Jan. 2007. Prior to Sept. 2008, we observe virtually no change (Fed) or relatively little change (ECB and BoE) in the balance sheets, but, beginning in Oct. 2008, we notice particularly large increases in the balance sheets of the Fed and BoE and a much more modest but still substantial increase for the ECB. Prior to Sept. 2008, the central banks sterilized the effects of the additional liquidity provided. The Fed did this by open market sales of T-bills, and the Treasury helped by selling supplemental Treasury securities to the public and depositing the proceeds in its account at the Fed, a procedure that drained reserves from the banking system. The ECB did this by reducing short-term repos at the same time it was engaging in

longer-term repos, and the BoE did this by engaging in open market sales and the sale of a new instrument—Bank of England bills (a non-monetary liability of the BoE with a maturity of 1 week)—to the public.

After Sept. 2008, the central banks stopped sterilizing the effects of the liquidity provision, and the size of the balance sheets and reserves began to rise substantially. The increase in the size of the balance sheets of the Fed and the BoE was accelerated by the adoption of Quantitative Easing (QE), which, as implemented by these banks, was simply open market purchases of longer-term securities. The ECB did not engage in quantitative easing to any extent although it did begin to purchase covered bonds in order to enhance the functioning of that market. A key reason the ECB did not engage in QE was that the size of its balance sheet at the beginning of the crisis was much larger than that of either the Fed or the BoE. Both the Fed and BoE made clear that a major purpose of QE was to reduce longer-term interest rates by significantly reducing the supply of longer-term bonds to the public. This was expected to raise the price of other assets like stocks as investors shifted from longer-term bonds into these assets.⁹ As discussed earlier, a reduction in long-term interest rates and rise in asset prices is expected to stimulate spending. Thus, QE was seen as a way of providing more stimulus to spending at a time when the zero-lower bound had been hit and policy rates couldn't be lowered further. Some economists (for example, Rudebusch (2009)) argued that given the low rates of inflation and substantial deviations of output from the natural level, some Taylor-type rules that relate the value of the policy rate to deviations of inflation from target and output from the natural level indicated that the best setting for the policy rate was a negative value, an impossible setting.¹⁰ The key point is that some guides for setting policy indicated that policy needed to be more stimulatory than could be achieved

⁹As Gagnon et al (2010) note, normal open market operations conducted using t-bills are small relative to the total amount of t-bills outstanding and hence there is little direct effect of the relatively small change in supply associated with normal open market operations on the yield on t-bills. However, the QE of the Fed and the BoE was designed to substantially reduce the supply of longer-term securities and thereby longer-term interest rates.

¹⁰However, the author of the original Taylor Rule, John Taylor (2010) has pointed out that the original Taylor Rule did not, and still does not, suggest a negative value for the policy rate.

with even a zero setting for the policy rate. Since changes in policy rates affect spending by altering longer-term interest rates, one option was to try to reduce longer-term rates by changing the supply of longer-term securities held by the public. The large-scale asset purchases under QE also raised reserves in the system, but the money supply has not risen to nearly the same extent as reserves since most of the reserves have been held as excess reserves and have not been loaned out.

In Nov. 2008, the Fed announced it would begin to purchase securities issued by Fannie Mae, Freddie Mac, and the Federal Home Loan Banks and MBS securities issued by Fannie Mae, Freddie Mac, and Ginnie Mae, and longer-term Treasury securities were later added to the list. This first round of long-term security purchases (QE1) ended in the first quarter of 2010 and resulted in the purchase of \$1.75t in long-term securities of which \$1.25t were MBS, \$200b were agency securities, and \$300b were Treasury securities. These purchases represented about 22% of the outstanding stock of these securities at the beginning of QE1. Initially the Fed did not replace maturing securities purchased under QE1, which meant that its balance sheet began to shrink in size. In Aug. 2010, it announced that it would replace maturing securities with longer-term U.S. Treasury securities, thereby maintaining the size of the Fed's balance sheet and hence the effects of QE on interest rates and asset prices. In Nov. 2010, in response to continuing weak economic activity and concern that underlying inflation was trending lower, the Fed announced that it would purchase another \$600b of longer-term U.S. Treasury securities by the middle of 2011; this program is referred to as QE2. Note that both QE1 and QE2 changed not only the size of the balance sheet but also its composition, so there are elements of both credit and quantitative easing in these programs. These programs also increased the risk level on the Fed's balance sheet since interest rate risk rises as the proportion of longer-term securities on the balance sheet rises.

The BoE began its program of QE in March 2009 with the express intent of increasing nominal demand sufficiently to hit the BoE's inflation target of 2% over the medium term. Earlier the BoE had been authorized, and had begun, to purchase £50b in corporate securities (CP and bonds) in order to improve the functioning of these markets, but these purchases were funded by t-bills issued by the Government and not by reserve creation. In March 2009, however, the range of securities was expanded to include Government longer-term bonds (gilts), and the security purchases were paid for by reserve creation. Under its QE program, the BoE purchased £200b in securities, of which £198b were gilts (20% of non-government holding of gilts). As is true for the Fed, the level of risk of the BoE's balance sheet has risen, although, unlike the Fed, the government has indemnified the BoE for any losses on the securities it acquired through QE and through its earlier purchases of corporate securities.

As noted earlier, the intent of QE was to lower longer-term interest rates, so it is important to try to determine whether this happened. Blinder (2010b) notes that after the Fed began QE the spread between the 3-month financial CP rate and the 3-month t-bill rate and the spread between Baa-rated corporate bonds and 10-year Treasury bonds fell substantially, but simply looking at what happened to the spreads after the implementation of QE doesn't control for other factors that might affect the spread. However, several studies including Gagnon et al (2010), D'Amico-King (2010), and Hamilton-Wu (2011) have more formally estimated the effects of QE easing on the level of interest rates. Chung et al (2011) summarize these studies as finding a significant reduction in the overall level of longer-term interest rates of about 50BP on both government and corporate bonds.¹¹ Chung et al (2011) note that, based on their estimates of the effect of a change in the federal funds rate on long-term rates, the effect of QE1 on long-term yields was approximately equal to a very expansionary 2% point cut in the fed funds rate. Krishnamurthy-Vissing-Jorgensen (2011) found significant effects of QE1 on yields of lower-

¹¹However, the earlier studies suggest there is a good bit of uncertainty about the true size of the effect of QE1 on interest rates.

risk securities (Treasury bonds, federal agency bonds, and highly-rated corporate bonds) but much smaller effects on riskier bonds like Baa corporate bonds. They found that the purchase of MBS in QE1 had significant effects on rates on MBS, but that the purchase of Treasury securities in QE1 had only small effects on the yields on MBS securities.

If we simply scale down the consensus estimated 50BP decline in long-term rates from QE1 for the size of QE2 relative to QE1, QE2 would be expected to have an approximate 17BP effect on long-term rates (equivalent to an approximate 0.7% decrease in the fed funds rate). This is approximately the same size effect as predicted by Hamilton (2010) who suggested effects in the neighborhood of 15-25BP. Krishnamurthy-Vissing-Jorgensen (2011) estimated the effects from QE2, and, as expected, found smaller effects than for QE1. They took into account that financial markets were functioning more normally during QE2 than QE1 in computing the effect of QE2. They also found significant increases in expected inflation as a result of both QE1 and QE2 thereby suggesting that the effects of these programs on real interest rates was larger than the effect on nominal interest rates and helped guard against deflation.

Joyce et al (2010) studied the effects of QE in the U.K. They looked at announcement effects of purchases under QE and also used a statistical model to estimate the effects of large scale purchases of securities. They found effects that averaged 50-100BP across bonds with maturities of 5-25 years, but found the effects were concentrated on longer-term securities.

Thus, extant studies for both the U.S. and the U.K. suggest significant effects of QE on longer-term interest rates. Chung et al (2011) estimated the effects of QE1 and QE2 on economic activity in the U.S. They used the FRB/US macro model developed at the Federal Reserve Board of Governors and assumed that there would be no change in the Fed's holdings of securities purchased under QE1 and 2 until late 2012 when the Fed would begin to slowly reduce its holdings. In their simulations, they found

effects of the combined QE programs to be equivalent to a 3% point cut in the fed funds rate. Stock prices rose and the dollar depreciated modestly. The level of real GDP increased by 3% by the second half of 2012 and the unemployment rate fell 1½% points. Inflation was estimated to be 1% point higher in 2011 than without QE, but over time as QE was phased out, their simulations indicated that the inflation rate fell back to its initial value.

Thus, the early studies suggest beneficial effects of QE. However, not everyone is convinced of the efficacy of QE. For a negative view of QE in general and QE2 in particular, see Cochrane (2011). No doubt future studies will reassess the effects of QE so our understanding of the effects of QE is likely to evolve over time.

Even if QE has been successful in stimulating aggregate demand and thereby helping move the economy toward normalcy, is there a longer run danger to QE? As we have noted, since QE involves the large-scale purchase of securities, reserves rise significantly. Normally, this would also generate a significant increase in the money supply. However, in the current crisis, most of the increase in reserves has been held as excess reserves by banks and hence haven't been used by banks to extend loans or buy securities. As the recovery begins to strengthen and regulatory uncertainty is reduced, loan demand should begin to revive and banks are likely to use their excess reserves to extend loans. There is thus the potential for a massive increase in the money supply as this happens with a consequent threat to price stability. Central banks are, of course, aware of this possibility and have thought about and discussed exit strategies from QE as the economy recovers.

Exit from QE and Other Crisis Policies

At the April 2011 FOMC meeting the Fed made clear (FOMC (2011)) that it wants to reduce the size of its balance sheet and return to its pre-crisis framework in which the Fed sets a target for the fed funds rate and holds only Treasury securities. Most participants in the meeting saw increases in the

target funds rate as the preferred tool for tightening monetary policy as the economy expands. An important question is how to move the actual funds rate to a higher target. One possibility is to simply engage in open market sales of securities purchased during QE—either outright sales of U.S. government securities and MBS or continual roll-over of reverse repurchase agreements. The Federal Reserve is concerned, however, that the scale of open market operations required to decrease reserves enough to raise the funds rate would have to be so large that bond markets would be disrupted and the recovery threatened. Consequently, most participants in the FOMC meeting believed that asset sales should be put on a largely predetermined and preannounced path, although the pace might be adjusted if there were substantial changes in economic activity. The initial step in the reduction of its holdings of securities would be to stop reinvestment of the principal on maturing securities. If open market sales are to be done only slowly over time, how then might a higher target funds rate be achieved? The preferred option is to raise the interest rate on reserves enough to induce banks to continue holding large volumes of excess reserves while reserves are being slowly drained from the system through open market sales. This process could be facilitated by use of the newly established term deposit facility in which the Fed offers term deposits (deposits with a specific maturity date) to financial institutions that are eligible to earn interest on their reserves at the Fed. Reserves shifted to term deposits are no longer classified as reserves, so as banks take out term deposits at the Fed, reserves in the system fall. The interest rate the Fed pays on term deposits will, of course, be greater than the interest rate on reserves, and changes in the interest rate paid on term deposits will affect the volume of reserves. The term deposit facility has already been implemented on a small scale in order for the Fed to gain experience with this facility.

With regard to the temporary liquidity facilities set up by the Fed, most have either expired or will expire relatively soon. The Fed will continue to pay interest on reserves, but this was a policy change that would have been implemented in Oct. 2011 even if there had been no crisis.

Like the Fed, the BoE has made clear that when it begins to tighten monetary policy it will first raise the target for its policy rate and then begin sales of securities acquired through QE. Fisher (2010) notes that the decision about the pace of security sales will depend on the outlook for inflation, but care will be taken not to unduly disrupt the operation of the gilt market. To that end, it will coordinate its sales with the Government's debt management office. With regard to its other programs, the last security swaps under the Special Liquidity Scheme will expire in Jan. 2012, and the facility will be closed at that time. The Discount Window Facility will continue as a permanent facility. The BoE does not expect its balance sheet to return to its pre-crisis level since it expects banks will want to hold more reserves than pre-crisis and because the range of banks that can hold reserve accounts was expanded during the crisis.

Unlike the Fed and the BoE, although the ECB bought a relatively small volume of covered bonds, it did not buy substantial volumes of securities and hence doesn't face the problem of how to divest itself of securities bought in the crisis. Instead, most of its liquidity provision took the form of longer term repos that are self-extinguishing. As noted in ECB (2010), the unconventional measures will be phased out in order to avoid disruptions to financial markets. For example, prior to the sovereign debt crisis in Europe, the ECB decided that the 1-year long-term repo in Dec. 2009 would be the last with that maturity, that the last 6-month repo would be in March 2010, and that supplemental 3-month repos would no longer be issued. However, the emergence of the European sovereign debt crisis caused the ECB to backtrack somewhat. In May 2010, it set up the Securities Markets Programme in which the ECB would purchase government and private securities in segments of the secondary market that were disrupted by the debt crisis, but these purchases will be completed sterilized so that there will be no effect on reserves. At the same time, it reintroduced 3-month and 6-month repos and resumed temporary currency swaps with the Fed. As the debt crisis eases, these operations will be phased out.

IV. Implications of the Crisis for Monetary Policy

The crisis and subsequent implementation of unconventional monetary policy by major central banks has raised a number of questions about monetary policy and its implementation. Mishkin (2011) discusses in detail the principles that guided monetary policy before the crisis and how the crisis might change monetary policy strategy, and the proper conduct of monetary policy in light of the crisis has been discussed by others as well. In this chapter, we can only briefly touch on some of the issues about monetary policy that will no doubt be debated intensely for some time to come.

One issue is how central banks should respond to asset price movements. Should central banks respond only indirectly to asset prices through their effects on aggregate demand or should central banks try to identify emerging asset price bubbles and “lean against” the rise in asset prices? If a bubble has developed, should the central bank proactively pop the bubble or should it clean up after a bubble pops on its own? Proponents of direct response argue that the bursting of asset price bubbles, especially those that are fueled by significant credit creation, can generate prolonged recessions, so it is better to try to deflate a bubble before it gets too big and bursts on its own. Opponents note that it is often difficult to identify asset price bubbles, since if fundamental determinants of asset prices have changed significantly, then substantial changes in asset prices are warranted. They also note that monetary policy is a “blunt tool” for dealing an asset price bubble since an increase in the policy rate affects not only the asset whose price is “bubbling” but also the prices of other assets and as well as consumption and investment spending. Some argue that it would be better to use macro-prudential regulation like changes in capital requirements, changes in loan-to-value ratios, and more stringer collateral requirements for repo lending than monetary policy to address emerging bubbles. Issing (2011) notes that before the current crisis central banks followed the “Jackson Hole Consensus” : don’t target asset prices, don’t try to prick a bubble, and “mop-up” after a bubble bursts. Both Issing (2011) and Mishkin (2011) note that this consensus is being rethought. Mishkin points out that it is much

easier to identify a credit driven bubble than one that stems from irrational exuberance and both Issing and Mishkin suggest that monitoring of credit market conditions will very likely become an essential part of the monetary and regulatory processes.

As noted earlier, prior to the current crisis, most regulation of financial institutions was micro-prudential in nature, i.e. the focus was on the health of the individual institution and less attention was paid to the interconnections among institutions and hence the possibility that problems at one institution would be transmitted to others connected to it. The crisis has revealed this to be a bad regulatory strategy, and macro-prudential regulation that aims to reduce systemic risks in the financial system is now considered essential. A key question is whether central banks should be the macro-prudential regulator or whether this should reside in another institution. Proponents of a separate regulator stress enhanced accountability since a separate regulator has a well-defined mission. They also note that vesting authority in a single institution responsible for both monetary and regulatory policy may create too powerful an institution, and regulatory responsibility, especially for systemically important institutions, might end up politicizing monetary policy. Proponents of central banks serving as the macro-prudential regulator argue that information obtained from regulation about the financial health and interconnections among institutions is useful in conducting normal monetary policy and in serving as lender of last resort. These proponents note that information sharing among different government agencies is typically less than perfect so it is better to have one institution perform both functions. For more detailed discussion see Blinder (2010a) and Mishkin (2011).

As discussed earlier, most central banks have a concern for inflation with a target inflation rate of 1-3%. The major central banks have an explicit or implicit target of 2% or slightly less. The BoE is an explicit inflation targeting bank, but the ECB and the Fed are not, although most observers believe they can be characterized as practicing flexible inflation targeting. As we noted earlier, the major central

banks essentially hit the zero lower bound for their policy rate during the crisis and hence had no further scope for lowering the policy rate. Consequently, they had to rely solely on unconventional policy at this point. Blanchard-Dell’Ariccia-Mauro (2010) argue that if central banks would raise their explicit or implicit target to 4%, then a central bank would have more scope for normal monetary policy and it would be less likely to hit the zero lower bound. A higher inflation target means higher expected inflation and higher nominal interest rates and hence more leeway for the central bank to reduce policy rates in a crisis. This is a very controversial proposal, and opponents point out that the costs of increasing the inflation target as well as the benefits must be considered. They worry that raising the target inflation rate would reduce the relatively recently hard-earned credibility of central banks as inflation fighters (Issing (2011)), and they argue that history suggests it is much more difficult to stabilize prices when inflation is above 3% than when it is below 3% (Mishkin (2011)). They also note the costs of higher inflation are continual, but the benefits of higher inflation are realized only when the zero lower bound is reached. Since it is rare for central banks to hit the zero lower bound, the benefits won’t be realized very often but the costs are ever present.

Finally, some have argued that price level targeting would be superior to the (explicit or implicit) flexible inflation targeting practiced by many central banks. With inflation targeting the central bank aims to achieve a target rate of inflation on average over the medium-to-long-run. From a particular point in time, a specific target inflation rate, say 2%, defines a particular path for the price level. Under inflation targeting, as the inflation rate falls below target, perhaps due to a negative shock to aggregate demand, the price level falls below the target price level path, but an inflation targeting central bank would respond only by engaging in a sufficiently expansionary monetary policy to return the inflation rate to the target rate. Expected inflation would remain the same. However, the price level thereafter would remain below the original path even though its rate of change would be at target. If the central bank practiced price level targeting, it would have to engage in a sufficiently expansionary monetary

policy to return the price level to its original path. This would require that the inflation rate rise above target for a period of time. If the public understood how the central bank operated, expected inflation would rise during the transition back to the price level path and this would reduce the real interest rate thereby reinforcing the cut in the policy rate and automatically providing more stimulus to the economy. Proponents of price level targeting argue price-level targeting would be even more effective at the zero lower bound. Under inflation targeting, the central bank would be expected to keep the policy rate at the zero lower bound just long enough to move inflation back to the target rate. Expected inflation would be unchanged, and the real policy rate would be the negative of the inflation target rate. Under credible price level targeting the central bank would be expected to keep the policy rate at the zero lower bound long enough to raise the inflation rate sufficiently above the target rate to return the price level to its original path. Expected inflation would rise above target and the real interest rate would be a larger negative number than under inflation targeting. Price level targeting at the zero lower bound would give a bigger boost to the economy than would inflation targeting. However, Walsh (2010) notes that this stabilizing effect depends on when price level targeting is adopted. He notes that if it had been adopted in Jan. 2007 with a price path based on a 2% inflation rate, prices would have risen above the path since inflation rose above 2% and this would have resulted in tighter monetary policy in 2007 and 2008 in order to bring the price level back to path and would also have generated expectations of deflation. This contractionary policy would have worsened the downturn. If price level targeting had been adopted in Jan. 2008, he notes the outcome would be more favorable to price level targeting. Mishkin (2011) also points out that it would generally be more difficult to communicate a price level target to the public than an inflation rate target. Thus, there are arguments pro and con for price level targeting over inflation targeting, and the debate over the appropriate policy will continue.

V. Conclusion

After the onset of financial crisis in 2007, monetary policymakers faced significant challenges. Financial markets were in turmoil, and normal credit flows were significantly disrupted. The major central banks responded in an aggressive way to improve the functioning of financial markets and to ease monetary policy. Central banks provided liquidity to financial market participants who were having difficult replenishing their funding through normal market channels and extended the maturity of their lending in light of the extensive and ongoing nature of the crisis. Existing operational facilities were used but the Bank of England and especially the Federal Reserve set up new lending facilities and the Federal Reserve used emergency powers to provide assistance to particular financial firms.

With regard to monetary policy, central banks sharply reduced their policy rates, effectively reaching the zero lower bound below which the policy rates couldn't be reduced further. The Federal Reserve attempted to enhance the effects of its policy rate cuts on longer-term interest rates by communicating "forward-guidance" to the public that, contingent on economic conditions, it was expected that these rates would remain at very low levels for an extended period of time. Neither the European Central Bank nor the Bank of England made this type of explicit statement, but instead relied on the public to draw inferences about the duration of their low policy rates from information about policy and the economic outlook provided by these banks. The Federal Reserve and the Bank of England also engaged in further monetary easing (quantitative easing) designed to further reduce long-term interest rates through large-scale purchases of longer-term securities—both government and non-government. These quantitative easing policies also provided credit easing to particular markets in the form of purchases of MBS (Federal Reserve) and corporate securities (Bank of England). Although the European Central Bank purchased covered bonds, it doesn't regard this action as quantitative easing.

As a consequence of the liquidity provision and monetary policy easing, the size of the balance sheets of the major central banks rose substantially after September 2008 and reserves and the monetary base rose sharply, although the money supply expanded by a much smaller magnitude since most of the reserves created were held idle by banks. Over time as financial markets return to normal, liquidity provision designed to enhance market functioning will naturally decrease and this will help shrink the balance sheets back towards normal levels. However, the central banks that engaged in quantitative easing are developing “exit strategies” that will help them shrink their balance sheets back towards a more normal size.

In their crisis response, central banks have demonstrated flexibility and a willingness to innovate, and have cooperated in several dimensions to help each other. Key elements of cooperation include the establishment of reciprocal currency swaps, the coordinated policy rate cut in Oct. 2008 after the crisis began to worsen, and the general discussion and sharing of information about policies and the state of financial markets and economic activity. The bulk of the evidence to date suggests that the actions of central banks have mitigated the effects of the crisis and have fostered recovery. However, lest central banks be considered paragons of policy virtue, it is important to note that some, like Taylor (2009), argue that misguided Federal Reserve policy from 2002-2006 that kept the federal funds rate too low for too long was the prime cause of the housing bubble whose bursting provided the trigger for the crisis. This strong assertion has been disputed by, among others, Bernanke (2010) who argues that Federal Reserve policy was appropriate given economic conditions and that monetary policy was not the cause of the housing bubble. It can be argued that regulators, including those at the Federal Reserve, did not understand very well the implications of financial innovations like subprime mortgages, their securitization, and the high degree of leverage of many financial institutions for the degree of systemic risk and that much more could have been done within the existing regulatory framework to have monitored and restrained systemic risk.

As a final note, if it wasn't before, it is now clear that financial crises can have dire consequences even for the most advanced economies, and the crisis and central bank responses have stimulated discussion of the appropriate way to implement monetary policy and the role of central banks in both micro-prudential and macro-prudential regulation. It seems clear that an important lesson from the crisis is that central banks, whether they are the ultimate micro- or macro-prudential regulator or not, must pay more attention to the level of systemic risk in formulating policy and how their monetary policies might affect the degree of systemic risk. Accordingly, central banks have begun the task of identifying indicators of the level of systemic risk and have begun the discussion of how this information will influence monetary policy decisions.

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Appendix: Details of Central Bank Actions

Federal Reserve

From Figure 1, we see that prior to the crisis the Fed's target for the federal funds rate was 5.25%. On Sept. 18, shortly after the emergence of the crisis, the Fed made a preemptory 50 basis points (BP) cut in the fed funds rate target. This was an anticipatory reaction to the expected future effects of the financial crisis since the economy was still strong and inflation was still rising at the time of this cut. Note that the Fed made two other 25BP cuts in 2007. In response to continued deterioration in the economic outlook, an intermeeting 75BP cut, the largest since 1994, was made by the Fed on Jan. 22, 2008, a week before the next regularly scheduled Federal Open Market Committee (FOMC) meeting. In light of continuing stress in financial markets and tightening credit to consumers and firms, a week later a 50BP cut was made, and this was followed by another 75BP cut in the March FOMC meeting and a 25BP cut in the April meeting. Thus, in less than a year, the Fed aggressively cut its funds rate target from 5.25% to 2% where it remained until Oct. 2008. The Fed cited expansion in overall economic activity and a diminution in downside risks to economic growth and continuing, but uncertain, inflation risk as evidenced in part by an increase in expected inflation in its decision to maintain the target at 2%.

On Oct. 8, 2008, an unprecedented coordinated cut in policy interest rates by the Fed, the ECB, the BoE, the Bank of Canada, the Sveriges Riksbank (Swedish central bank), and the Swiss National Bank was announced. By Dec. 2008, the Fed had cut its target for the funds rate to a range of 0%-0.25%. The Fed's move to a target range was done in recognition of the fact that achieving a specific numerical target for the funds rate could be difficult given the large volume of reserves in the system. In an attempt to condition (manage) expectations of future values of the fed funds rate and hence magnify the effect of its cut in the target funds rate on longer-term interest rates, the Fed added the following statement to its press release following its January 2009 FOMC meeting: "...the Committee anticipates that weak economic conditions are likely to warrant exceptionally low levels of the federal funds rate for some time." The language about expected values of the future fed funds rate was strengthened somewhat in the March 2009 meeting when the phrase "for some time" was replaced by "for an extended period", and this new phrase has been included in all FOMC statements since then.

In its role as lender of last resort, the Fed provided massive amounts of liquidity to financial institutions during the crisis. It encouraged banks to borrow from its existing lending facility, the discount window, extended the maturity of loans, broadened the collateral for loans, created new lending facilities, and used its authority under section 13(3) of the Federal Reserve Act to extend lending beyond banks to other financial market participants. Section 13(3) allows the Fed, in unusual and exigent circumstances, to lend to individuals, partnerships, and corporations that are unable to obtain adequate credit.

There are different ways to organize a discussion of the Fed's provision of liquidity to the financial system, and one instructive way is to consider Fed actions directed toward banks, the operation of particular financial markets, specific firms, and other central banks. We address each of these in turn.

We first consider liquidity supplying actions directed toward banks. In Sept. 2007, in order to encourage borrowing from the discount window, the Fed reduced the penalty spread on the interest rate charged

on discount window loans (the primary credit rate) from a 1% point mark-up over the fed funds rate target to a 50BP mark-up. The mark-up was cut further to 25BP in March 2008. Simultaneously with these cuts, the maximum length of discount window loans was first raised to 30 days and then later to 90 days. Borrowings at the discount window began to rise sharply after mid-2008 and peaked at over \$400b in late 2008. The volume has fallen substantially over time but still remains well above the pre-crisis borrowing level.¹²

Even though borrowing from the discount window rose significantly, the increased borrowing was less than the Fed thought necessary, and, in Dec. 2007, the Fed set up a temporary lending facility called the Term Auction Facility. The Term Auction Facility auctioned funds for either 28 or 84 days to banks at a rate determined in a competitive auction, and the rate established was often lower than the primary credit rate. The Fed believed the TAF reduced the stigma often associated with borrowing from the discount window because of the competitive bidding format and, because there was lag between the auction and the settlement of the loan, banks borrowing through the TAF did not appear desperate for funds. Borrowing rose steadily through mid-2008 and then rose sharply after Oct. 2008, peaking at approximately \$500b in early 2009. Borrowings declined steadily from the peak and the last auction was held in March 2010. The facility is now shut down. Further, in Mar. 2008 the Fed instituted 28-day term repurchase agreements for which a wide variety of collateral—including federal agency and private investment grade MBS—was accepted. \$80b of these term repos were executed, but the volume is now back to zero.

Next consider the actions directed toward financial markets in general and to specific financial markets. Under its Section 13(3) authority, the Fed set up two temporary lending facilities for primary government security dealers in March 2008. These dealers maintain an inventory of government and private securities and are important for the smooth functioning of financial markets. These dealers are also the normal counterparties for the Fed's open market operations. The Primary Dealer Credit Facility provided overnight loans at the primary credit rate to these dealers. A broader range of collateral than that eligible at the discount window was accepted, and this included investment grade MBS as well as other asset backed securities. The intent was to enhance the dealers' ability to provide financing to participants in securitization markets and hence to insure the orderly functioning of financial markets in general. Borrowing quickly rose to approximately \$40b, declined to zero before Sept. 2008, and then jumped sharply to approximately \$150b in late 2008. Borrowing declined steadily thereafter, and the facility closed in Feb. 2010. The second facility was the Term Security Lending Facility through which the Fed loaned U.S. Treasury securities to primary dealers for a term of 28 days with federal government agency debt and federal agency and AAA-rated private MBS as collateral. The intent was to enhance the liquidity of dealer portfolios and thereby promote more normal functioning of financial markets. The value of securities loaned quickly jumped to about \$160b, and peaked at close to \$240b in Oct. 2008. The volume of borrowed securities declined steadily after this, and the facility was shut down in Feb. 2010. Note that since this facility loaned securities rather than funds, banking system reserves and the

¹²The Fed has subsequently raised the spread back to 50BP and has cut the maximum term of the discount window loans to 28 days.

money supply were not affected by loans through the Term Securities Lending Facility, unlike loans through the Primary Dealer Credit Facility.

The asset-backed commercial paper market was severely disrupted during the crisis, and the Fed used its Section 13(3) authority to set up three facilities to provide direct and indirect support to the CP market, but only two of these facilities were actually used. The Asset-Backed CP Money Market Mutual Fund Liquidity Facility was set up in Sept. 2008 and operated until Feb. 2010. Through this facility the Fed provided loans to depository institutions to finance the purchase of high-quality asset-backed commercial paper from money market mutual funds, which were among the most important purchasers of asset-backed commercial paper and which had experienced significant withdrawals by institutional shareholders. These purchases provided funds to money market mutual funds that allowed them to purchase newly issued asset-backed commercial paper. Loans through this facility quickly rose to almost \$150b, and then declined and reached zero in Aug. 2009. The Commercial Paper Funding Facility began operations in Oct. 2008 and closed on Feb. 2010. The Fed supported the CP market through this facility by setting up a legal entity called a Special Purpose Vehicle (SPV) and making loans to the SPV that enabled the SPV to purchase newly issued unsecured and asset-backed CP directly from the issuer. These transactions were handled by the primary government security dealers and were intended to provide liquidity to the CP market. The volume of loans through this facility rose to more than \$350b in early 2009 and then declined steadily over time as the CP market recovered. The Fed also set up the Money Market Investor Funding Facility in Oct. 2008, but it was shut down a year later without being used. The idea was to enhance the liquidity of the CP market by providing funds via a SPV to money market mutual funds based on collateral like high-quality CP.

The Fed also provided support to the asset-backed securities market through the Term Asset-Backed Securities Loan Facility. It was authorized under Section 13(3) authority in Nov. 2008 and began operations in Feb. 2010. New loans through this facility ended on June 30, 2010, and the facility will be shut down when outstanding loans are paid off. Through this facility the Fed extended loans of up to 5 years to holders of newly or recently issued high-quality asset-backed securities backed by auto loans, credit card loans, student loans, small business loans, commercial mortgages, and residential mortgages. The intent was to support asset-backed security markets and thereby help credit markets meet the needs of students, households, and small businesses. Loans through this facility grew over time to a peak of slightly less than \$50b in April 2010 and began to decline thereafter.

In order to prevent even more serious dysfunction in financial markets, the Fed also used its 13(3) authority to provide support to specific firms. To facilitate JP Morgan Chase's merger with Bear Stearns, the fifth-largest investment bank that had suffered heavy losses from its large holdings of MBS backed by subprime mortgages, the Fed set up a legal entity that used \$29b in funds loaned to it by the Fed to purchase subprime-related assets from Bear Stearns. AIG, a large insurance company that had written over \$400b in credit default swaps (insurance contracts that insured the purchaser of the credit default swap, typically the issuer of MBS or collateralized debt obligations, against default on the insured securities), teetered on the brink of failure in Sept. 2008 as it faced the possibility of having to pay off the credit default swaps. In Sept. 2008, the Fed authorized up to \$85b in secured funding to AIG and further support was provided in Oct. and Nov. Total loans to AIG grew to \$173b.

Finally, the Fed also entered into reciprocal currency agreements—currency swaps—with other central banks. During the crisis, there was strong demand for U.S. dollars by foreign financial institutions. This strong demand often contributed to sharp changes in the fed funds rate as foreign institutions tried to borrow dollars. The Fed loaned dollars to foreign central banks in exchange for foreign currency, and the foreign central banks made dollar loans to financial institutions in their country. Swaps were first arranged with the ECB and the Swiss National Bank in Dec. 2007, but were later arranged with a number of other central banks. The volume of these swaps reached almost \$600b in late 2008 and early 2009, but has returned to essentially zero today.

The new liquidity facilities introduced by the Fed expanded the range of counterparties and the range of collateral accepted by the Fed. Consequently, the riskiness of the Fed's balance sheet expanded, and the possibility of losses on the lending rose. Fleming and Klagge (2011) analyze the income generated by the new and expanded facilities and the associated cost of funds and note that from 2007-2009 the net income to the Fed from the new and expanded facilities was approximately \$13b. They also note there had been no credit losses associated with these facilities through the date of their analysis.

As a result of these initiatives, borrowing from the Fed rose substantially. However, until Oct. 2008, the Fed sterilized the effects of the borrowing on reserves by engaging in open market sales of Treasury securities. The Treasury also helped out by selling supplemental securities to the public and then depositing the proceeds in its accounts at the Fed, a procedure that drained reserves from the banking system. After Oct. 2008, the volume of reserves began to rise substantially, and this rise reflected not only the increased borrowing from the Fed but also the implementation of QE by the Fed. In Nov. 2008, the Fed announced it would begin to purchase securities issued by Fannie Mae, Freddie Mac, and the Federal Home Loan Banks and MBS securities issued by Fannie Mae, Freddie Mac, and Ginnie Mae. Purchase of up to \$100b in agency securities and \$500b in MBS was initially authorized. The purchases began in Jan. 2009, and in March 2009 the Fed announced an increase to \$200b for agency security purchases and an increase to \$1.25t for MBS purchases. It was further announced that \$300b in longer term U.S. Treasury securities would be purchased. This first round of long-term security purchases (QE1) ended in the first quarter of 2010 and resulted in the purchase of \$1.75t in long-term securities. Initially the Fed did not replace maturing securities purchased under QE1, which meant that its balance sheet began to shrink in size. In Aug. 2010, it announced that it would replace maturing securities with longer-term U.S. Treasury securities, thereby maintaining the size of the Fed's balance sheet and hence the effects of QE on interest rates and asset prices. In Nov. 2010, the Fed announced that it would purchase another \$600b of longer-term U.S. Treasury securities by the middle of 2011; this program is referred to as QE2.

European Central Bank¹³

The ECB also undertook both conventional and unconventional actions as part of its response to the crisis. From Figure 1, we note that the ECB maintained its target for its policy rate (main refinancing rate) through June 2008 and then raised its target for the policy rate in July 2008 in light of rising

¹³Much of the discussion in this section is based on ECB (2010).

inflation stemming from adverse supply shocks. The ECB began cutting its target for the policy rate in Oct. 2008 as part of the coordinated policy rate cuts by a number of central banks, and by April 2009 had cut it to 1%. Although the ECB did not cut its target to as low a level as the Fed, beginning in mid-2009 the actual value of the overnight interest rate (EONIA) was allowed to fall very close to the deposit lending rate of 0.25% at that time, so effectively the ECB had hit the zero lower bound by July 2008. The ECB also adjusted the “mark-up” of its lending rate at its borrowing facility and “mark-down” of its deposit rate relative to its policy rate in Oct. 2008 from 1% point to 0.5% point. In Jan. 2009 the mark-up and mark-down were adjusted back to 1% point and then to 0.75% in April 2009. At that time the deposit rate was 0.25% and the lending rate was 1.75%.

Although it maintained its policy rate target unchanged until July 2008 when it raised it, the ECB responded quickly to the emergence of the crisis in August 2007 within the context of its normal operating procedures. Initially it allowed banks to obtain as much overnight liquidity as needed at the main refinancing rate through the execution of repos with the ECB. In subsequent months, the ECB conducted supplemental repos with terms of 3 and 6 months, while at the same time reducing repos with shorter terms. Consequently, there was relatively little change in reserves initially. To keep the EONIA rate close to the main refinancing rate, the ECB engaged in fine-tuning (overnight) refinancing operations. Most of the liquidity was provided through repos; there was little change in the low volume of borrowing at the ECB lending facility. The range of counterparties was extended as well. In Dec. 2007, the ECB engaged in currency swaps with the Fed in order to provide dollars to Euro-area banks.

Beginning in Oct. 2008, after the worsening of the crisis, the ECB adopted several temporary non-standard measures collectively called “enhanced credit support”. The following elements were included in the enhanced credit support:

(a) the ECB implemented “fixed full rate allotment” for its repos under which it allowed financial institutions to obtain the full amount of liquidity they wanted at the main refinancing rate, conditioned on providing adequate collateral for the repos.

(b) in order to provide more access to its refinancing operations, it broadened the range of collateral for its refinancing operations and extended the list of counterparties for refinancing operations. The share of illiquid assets including asset-backed securities used as collateral for repos rose significantly during the crisis period.

(c) in order to provide more extended and stable funding for financial institutions, it announced an intent to provide more funding through refinancing operations with a maturity of up to 6 months, and, in May 2009, it announced refinancing operations with a maturity of 1 year. The intent was to minimize disruptions to credit provision by banks. Lenza et al (2010) note that the announcement of longer-maturity repos was interpreted by some as a signal that the ECB would maintain a low level of the interest rate in the future even though the ECB indicated it would not commit to a future path for the policy rate.

(d) in May 2009, it announced it would purchase €60b in euro-denominated covered bonds in order to help restore functioning of this market. Covered bonds have some similarities to MBS, except the underlying assets (the cover pool), typically mortgages, are retained on the issuing bank's consolidated balance sheet. Covered bonds are an important source of financing for banks in Europe, so restoration of the functioning of this market was a high priority for the ECB.

As was the case for the U.S., most of the additional reserves created by the non-standard procedures of the ECB were simply deposited in the ECB's deposit facility. After financial markets stabilized in 2009, the ECB decided in Dec. 2009 to phase out the non-standard procedures that were no longer needed. Since much of the liquidity was provided by repos, this meant liquidity provided could be scaled back by not renewing the repos at maturity. For example, the ECB decided that Dec. 2009 would be the last month the repos with a 1 year maturity would be issued, that only 1 more the 6-month repo operation would be conducted in March 2010, and that the supplemental 3-month repos would be terminated.¹⁴

Bank of England

As was the case for the Fed and the ECB, the BoE also undertook both conventional and unconventional actions as part of its response to the crisis. From Figure 1, we see that the BoE raised its target for the policy rate (the bank rate) twice in 2007 because of inflation concerns before it began a series of cuts in Dec. 2007 that took the bank rate target to 0.5% in March 2009 where it has remained since then. The BoE participated in the coordinated policy rate cut in Oct. 2008 by cutting its target by 50BP. Unlike the Fed but like the ECB, the BoE did not provide explicit forward guidance about its target bank rate, but instead allowed the public to form its own expectations from bank communications like the quarterly *Inflation Report* published by the BoE. The BoE maintained its normal 1% point differential between the lending and deposit rates and the bank rate target until Oct. 2008 when it cut the differential to 0.25% points. When it cut its target policy rate to 0.5% in March 2009, it also began to pay interest on reserves at the bank rate.¹⁵

In Dec. 2007 the BoE also began to provide longer-term liquidity to financial institutions by offering a larger volume of extended collateral long-term repos that had a 3-month maturity and an expanded range of collateral that included AAA-rated residential MBS and covered bonds. In autumn 2008, the range of collateral was extended further to include commercial MBS and corporate bonds. Liquidity extended through these repos peaked in Jan. 2009 at £180b. In Sept. 2008, the BoE established a currency swap facility with the Fed and offered to lend banks dollars. At first this was done on an overnight basis, the maturity was later extended to a week and then to 1-3 months. At the peak these loans were \$86b.

¹⁴In May 2010, in response to the sovereign debt crisis in Europe, the ECB started the Securities Markets Programme in which the ECB would purchase government bonds in the secondary market in order to insure the proper functioning of the segments of this market hit by the sovereign debt crisis. At the same time, the ECB sterilized the effects of the government debt purchases on through its liquidity-absorbing operations.

¹⁵At the same time it cut the interest rate at its deposit facility to 0 which meant that any bank that held reserves would not use the deposit facility. There were, however, some institutions that had access to the deposit facility that didn't hold reserves, and after March 2009 there was no incentive for these institutions to use the deposit facility.

In order to provide further support to banks and financial markets, the BoE established the Special Liquidity Scheme in April 2008 as a temporary facility that will terminate in Jan. 2012. This facility allows banks and building societies to swap high-quality but temporarily illiquid MBS and other securities for UK government T-bills. The BoE's holdings of the risky, illiquid assets are indemnified by the Treasury so that the BoE will not suffer a loss if one of these securities goes into default. In Oct. 2008, the BoE established the Discount Window Facility as a permanent facility. Its function is the same as the Special Liquidity Scheme—it allows banks to borrow government bonds against a wide range of collateral. In this facility the normal borrowing period is 30 days, but for an additional fee the borrowing period can be extended to a year.

Until March 2009 when QE was introduced, much of the increase in reserves generated through liquidity provision was sterilized through open market operations and the sale of a new instrument-- Bank of England bills which were a non-monetary liability of the BoE with a maturity of 1 week. At the peak, over £100b of these bills were sold to banks. In Jan. 2009, the Government authorized the BoE to purchase £50b of corporate securities (commercial paper and bonds) in order to improve the functioning of credit markets. These purchases were to be implemented through a subsidiary of the BoE, the BoE Asset Purchase Facility Fund and were initially to be funded by T-bills issued by the Government. The BoE is fully indemnified against losses in this Fund by the Government. Purchases of corporate securities were made, but before the March 2009 meeting of the monetary policy committee, the BoE was authorized to use this Fund as a monetary policy tool that would be used to increase reserves and hence the size of the BoE balance sheet. Purchases through this facility would be paid for by reserve creation, and the range of securities that could be purchased was expanded to include UK government long-term bonds (gilts) as well as corporate securities. After the March 2009 monetary policy meeting, the BoE announced it would undertake large scale asset purchases financed by reserve creation with the aim of increasing nominal demand sufficiently to hit the BoE's inflation target of 2% in the medium term. By Feb. 2010, the BoE had purchased £200b in securities through this facility with most of the purchases being gilts (£198b). The purchases of gilts amount to approximately 20% of non-government holdings of gilts. Since Feb. 2010, the BoE has continued to purchase and sell corporate securities in order to enhance liquidity in corporate security markets, but purchases have been financed by the sale of T-bills rather than reserve creation. However, the BoE has maintained its holdings securities purchased in its QE program and has not yet begun to unwind the effects of QE on reserves and the balance sheet.

Figure 1: Policy Rate Targets 2007-2011

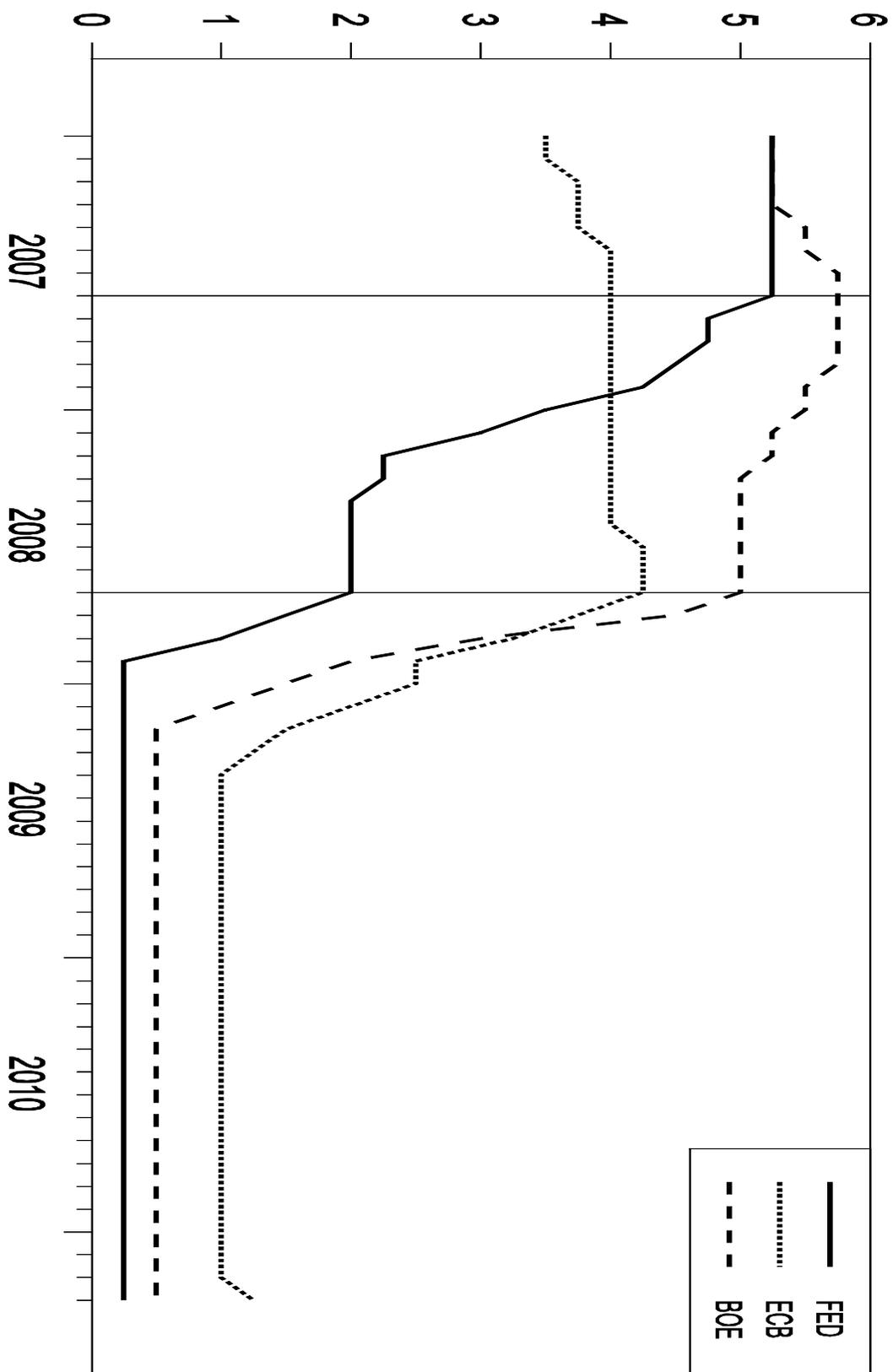


Figure 2: Total Assets 2007-2011

