Todd Keister, Antoine Martin, and James McAndrews

Divorcing Money from Monetary Policy

- Many central banks operate in a way that creates a tight link between money and monetary policy, as the supply of reserves must be set precisely in order to implement the target interest rate.
- Because reserves play other key roles in the economy, this link can generate tensions with central banks' other objectives, particularly in periods of acute market stress.
- An alternative approach to monetary policy implementation can eliminate the tension between money and monetary policy by "divorcing" the quantity of reserves from the interest rate target.
- By paying interest on reserve balances at its target interest rate, a central bank can increase the supply of reserves without driving market interest rates below the target.
- This "floor-system" approach allows the central bank to set the supply of reserve balances according to the payment or liquidity needs of financial markets while simultaneously encouraging the efficient allocation of resources.

1. Introduction

Monetary policy has traditionally been viewed as the process by which a central bank uses its influence over the supply of money to promote its economic objectives. For example, Milton Friedman (1959, p. 24) defined the tools of monetary policy to be those "powers that enable the [Federal Reserve] System to determine the total amount of money in existence or to alter that amount." In fact, the very term *monetary policy* suggests a central bank's policy toward the supply of money or the level of some monetary aggregate.

In recent decades, however, central banks have moved away from a direct focus on measures of the money supply. The primary focus of monetary policy has instead become the value of a short-term interest rate. In the United States, for example, the Federal Reserve's Federal Open Market Committee (FOMC) announces a rate that it wishes to prevail in the federal funds market, where overnight loans are made among commercial banks. The tools of monetary policy are then used to guide the market interest rate toward the chosen target. For this reason, we follow the common practice of using the term *monetary policy* to refer to a central bank's interest rate policy.

It is important to realize, however, that the quantity of money and monetary policy remain fundamentally linked under this approach. Commercial banks hold money in the form of reserve balances at the central bank; these balances are used to meet reserve requirements and make interbank

Todd Keister and Antoine Martin are research officers and James McAndrews a senior vice president at the Federal Reserve Bank of New York.
<todd.keister@ny.frb.org>
<antoine.martin@ny.frb.org>
<james.mcandrews@ny.frb.org>

payments. The quantity of reserve balances demanded by banks varies inversely with the short-term interest rate because this rate represents the opportunity cost of holding reserves. The central bank aims to manipulate the supply of reserve balances—for example, through open market operations that exchange reserve balances for bonds—so that the marginal value of a unit of reserves to the banking sector equals the target interest rate. The interbank market for short-term funds will then clear with most trades taking place at or near the target rate. In other words, the quantity of money (especially reserve balances) is chosen by the central bank in order to achieve its interest rate target.

[The] link between money and monetary policy can generate tension with central banks' other objectives because bank reserves play other important roles in the economy.

This link between money and monetary policy can generate tension with central banks' other objectives because bank reserves play other important roles in the economy. In particular, reserve balances are used to make interbank payments; thus, they serve as the final form of settlement for a vast array of transactions. The quantity of reserves needed for payment purposes typically far exceeds the quantity consistent with the central bank's desired interest rate. As a result, central banks must perform a balancing act, drastically increasing the supply of reserves during the day for payment purposes through the provision of *daylight reserves* (also called *daylight credit*) and then shrinking the supply back at the end of the day to be consistent with the desired market interest rate.

Recent experience has shown that central banks perform this balancing act well most of the time. Nevertheless, it is important to understand the tension between the daylight and overnight need for reserves and the potential problems that may arise. One concern is that central banks typically provide daylight reserves by lending directly to banks, which may expose the central bank to substantial credit risk. Such lending may also generate moral hazard problems and exacerbate the too-big-to-fail problem, whereby regulators would be reluctant to close a financially troubled bank.

The tension is clearest during times of acute stress in financial markets. In the days following September 11, 2001, for example, the Federal Reserve provided an unusually large quantity of reserves in order to promote the efficient functioning of the payments system and financial markets more generally. As a result of this action, the fed funds rate fell substantially below the target level for several days.[1]

During the financial turmoil that began in August 2007, the tension was much longer lasting. Sharp increases in spreads between the yields on liquid and illiquid assets indicated a classic *liquidity shortage*: an increased demand for liquid assets relative to their illiquid counterparts. By increasing the supply of the most liquid asset in the economy—bank reserves—the Federal Reserve could likely have eased the shortage and helped push spreads back toward more normal levels. Doing so, however, would have driven the market interest rate below the FOMC's target rate and thus interfered with monetary policy objectives. Instead, the Federal Reserve developed new, indirect methods of supplying liquid assets to the private sector, such as providing loans of Treasury securities against less liquid collateral through the Term Securities Lending Facility.

Recently, attention has turned to an alternative approach to monetary policy implementation that has the potential to eliminate the basic tension between money and monetary policy by effectively "divorcing" the quantity of reserves from the interest rate target. The basic idea behind this approach is to remove the opportunity cost to commercial banks of holding reserve balances by paying interest on these balances at the prevailing target rate. Under this system, the interest rate paid on reserves forms a *floor* below which the market rate cannot fall. The supply of reserves could therefore be increased substantially without moving the short-term interest rate away from its target. Such an increase could be used to provide liquidity during times of stress or to reduce the need for daylight credit on a regular basis.[2] A particular version of the "floor-system" approach has recently been adopted by the Reserve Bank of New Zealand.

It is important to understand the tension between the daylight and overnight need for reserves and the potential problems that may arise.

It should be noted that adopting a floor-system approach requires the central bank to pay interest on reserves, something

[1] Intraday volatility of the fed funds rate remained high, with trades being executed far from the target rate, for several weeks. See McAndrews and Potter (2002) and Martin (forthcoming) for detailed discussions.

[2] This approach has been advocated in various forms by Woodford (2000), Goodfriend (2002), Lacker (2006), and Whitesell (2006b).

the Federal Reserve has historically lacked authorization to do. However, the Financial Services Regulatory Relief Act of 2006 will give the Federal Reserve, for the first time, explicit authority to pay interest on reserve balances, beginning on October 1, 2011. A floor system will therefore soon be a feasible option for monetary policy implementation in the United States.

In this article, we present a simple, graphical model of the monetary policy implementation process to show how the floor system divorces money from monetary policy. Our aim is to present the fundamental ideas in a way that is accessible to a broad audience. Section 2 describes the process by which monetary policy is currently implemented in the United States and in other countries. Section 3 discusses the tensions that can arise in this framework between monetary policy and payments/liquidity policy. Section 4 illustrates how the floor system works; it also discusses potential issues associated with adopting this type of system in a large economy such as the United States. Section 5 concludes.

2. An Overview of Monetary Policy Implementation

In this section, we describe a stylized model of the process through which many of the world's central banks implement monetary policy. Our model focuses on the relationship between the demand for reserve balances and the interest rate in the interbank market for overnight loans. Following Poole (1968), a variety of papers have developed formal models of portfolio choice by individual banks and derived the resulting aggregate demand for reserves.[3] Our graphical model of aggregate reserve demand is consistent with these more formal approaches. We first discuss the system currently used in the United States and then describe a symmetric channel system, as used by a number of other central banks.

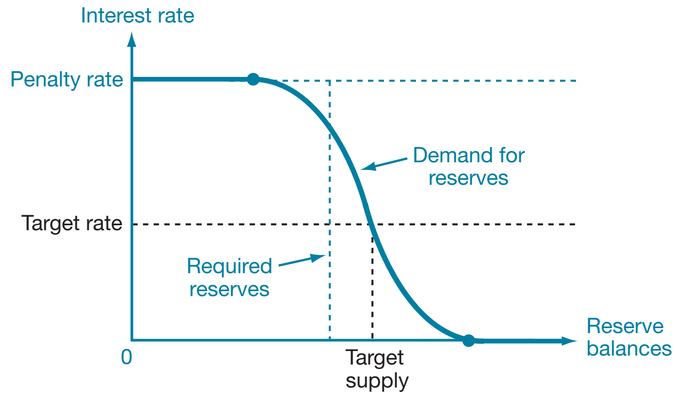
2.1 Monetary Policy Implementation in the United States

We begin by examining the total demand for reserve balances by the U.S. banking system. In our stylized framework, this demand is generated by a combination of two factors. First, banks face reserve requirements. If a bank's final balance is smaller than its requirement, it pays a penalty that is proportional to the shortfall. Second, banks experience unanticipated late-day payment flows into and out of their reserve account after the interbank market has closed. A bank's final reserve balance, therefore, may be either higher or lower than the quantity of reserves it chooses to hold in the interbank market. This uncertainty makes it difficult for a bank to satisfy its requirement exactly and generates a "precautionary" demand for reserves.

For simplicity, we abstract from a number of features of reality that, while important, are not essential to understanding the basic framework. For example, we assume that reserve requirements must be met on a daily basis, rather than on average over a two-week reserve maintenance period. Alternatively, one can interpret our model as applying to *average* reserve balances (and the average overnight interest rate) over a maintenance period. In addition, we do not explicitly include vault cash in the analysis, using the terms *reserve balances* and *reserves* interchangeably.[4]

Exhibit 1 presents the aggregate demand for reserves in our framework. The horizontal axis measures the total quantity of reserve balances held by banks while the vertical axis measures the market interest rate for overnight loans of these balances. The *penalty rate* labeled on the vertical axis represents the interest rate a bank pays if it must borrow funds at the end of

Exhibit 1
Monetary Policy Implementation in the United States



[3] Recent contributions include Furfine (2000), Guthrie and Wright (2000), Bartolini, Bertola, and Prati (2002), Clouse and Dow (2002), Whitesell (2006a, b), and Ennis and Weinberg (2007).

[4] Required reserves should therefore be interpreted as a bank's requirement net of its vault cash holdings. To the extent that vault cash holdings are independent of the overnight rate, at least over short horizons, including them in our model would have no effect. We also abstract from the Contractual Clearing Balance program, which allows banks to earn credit for priced services at the Federal Reserve by holding a contractually agreed amount of reserves in excess of their requirement; these contractual arrangements, once set, act much like reserves requirements.

the period to meet its requirement. One can interpret this penalty rate as the interest rate charged at the Federal Reserve's primary credit facility (the discount window), adjusted by any "stigma" costs that banks perceive to be associated with borrowing at this facility. The important feature of the penalty rate is that it lies above the FOMC's target interest rate.[5]

> *The . . . demand for reserve balances will vary inversely with the market interest rate, since this rate represents the opportunity cost of holding reserves.*

To explain the shape of the demand curve in the exhibit, we ask: given a particular value for the interest rate, what quantity of reserve balances would banks demand to hold if that rate prevailed in the interbank market? First, note that if the market interest rate were above the penalty rate, there would be an arbitrage opportunity: banks could borrow reserves at the (lower) penalty rate and lend them at the (higher) market interest rate. If the market interest rate were exactly equal to the penalty rate, however, banks would be willing to hold some reserve balances toward meeting their requirements. In fact, each bank would be indifferent between holding reserves directly and borrowing at the penalty rate as long as it is sure that late-day payment inflows will not leave it holding excess balances at the end of the day. As a result, the demand curve is flat—reflecting this indifference—at the level of the penalty rate for sufficiently small levels of reserve balances.

For interest rates below the penalty rate, each bank will choose to hold a quantity of reserves that is close to the level of its requirement; hence, aggregate reserve demand will be close to the total level of required reserves. However, as described above, banks face uncertainty about their final account balance that prevents them from being able to meet their requirement exactly. Instead, each bank must balance the possibility of falling short of its requirement—and being forced to pay the penalty rate—against the possibility that it will end up holding more reserves than are required. As no interest is paid on reserves, holding excess balances is also costly. The resulting demand for reserve balances will vary inversely with the market interest rate, since this rate represents the opportunity cost of holding reserves. The less expensive it is to hold precautionary reserve balances, the greater the quantity demanded by the banking system will be. This reasoning generates the downward-sloping part of the demand curve in the exhibit.

If the market interest rate were very low—close to zero—the opportunity cost of holding reserves would be very small. In this case, each bank would hold enough precautionary reserves to be virtually certain that unforeseen payment flows will not decrease its reserve balance below the required level. In other words, each bank would choose to be "fully insured" against the possibility of falling short of its requirements. The point in Exhibit 1 where the demand curve intersects the horizontal axis represents the total of this fully insured quantity of reserve balances for all banks. The banking system will not demand more than this quantity of reserve balances as long as there is some opportunity cost, no matter how small, of holding these reserves.

If the market interest rate were exactly zero, however, there would be no opportunity cost of holding reserves. In this limiting case, there is no cost at all to a bank of holding additional reserves above the fully insured amount. The demand curve is therefore flat along the horizontal axis after this point; banks are indifferent between any quantities of reserves above the fully insured amount when the market interest rate is exactly zero.

Needless to say, our model of reserve demand abstracts from important features of reality. Holding more reserves, for example, might require a bank to raise more deposits and subject it to higher capital requirements. Nevertheless, the model is useful because it lays out, in perhaps the simplest way possible, the basic relationship between the market interest rate and the demand for reserves that results from the optimal portfolio decisions of banks. Moreover, small changes in the shape of the demand curve would have no material effect on the analysis that follows.

The equilibrium interest rate in our model is determined by the height of the demand curve at the level of reserve balances supplied by the Federal Reserve. If the supply is smaller than the total amount of required reserves, for example, the equilibrium interest rate would be near the penalty rate. If, however, the supply of reserves were very large, the equilibrium interest rate would be zero. Between these two extremes, on the downward-sloping portion of the demand curve, there is a *liquidity effect* of reserve balances on the market interest

[5] The interest rate charged on discount window loans has been set above the FOMC's target rate since the facility was redesigned in 2003. The gap between the two rates was initially set at 100 basis points, but has since been lowered to 50 basis points (in August 2007) and to 25 basis points (in March 2008). In addition, there is evidence that banks attach a substantial nonpecuniary cost to borrowing from the discount window, as they sometimes borrow in the interbank market at interest rates significantly higher than the discount window rate. These stigma costs may reflect a fear that other market participants will find out about the loan and interpret it as a sign of financial weakness on the part of the borrowing bank.

rate: a higher supply of reserves will lower the equilibrium interest rate.[6]

As shown in the exhibit, there is a unique level of reserve supply that will lead the market to clear at the FOMC's announced target rate; we call this level the *target supply*. Monetary policy is implemented through open market operations that aim to set the supply of reserves to this target level. This process requires the Fed's Open Market Desk to accurately forecast both reserve demand and changes in the existing supply of reserves attributable to autonomous factors

Monetary policy is implemented in the United States by changing the supply of reserves in such a way that the fed funds market will clear at the desired rate. In other words, the stock of "money" is set in order to achieve a monetary policy objective.

such as payments into and out of the Treasury's account. Forecasting errors will lead the actual supply to deviate from the target and, hence, will cause the market interest rate to differ from the target rate. In our simple model, the downward-sloping portion of the demand curve may be quite steep, indicating that relatively small forecasting errors could lead to substantial interest rate volatility. In reality, a variety of institutional arrangements, including reserve maintenance periods, are designed to flatten this curve and thus limit the volatility associated with forecasting errors.[7]

The key point of this discussion is that monetary policy is implemented in the United States by changing the supply of reserves in such a way that the fed funds market will clear at the desired rate. In other words, the stock of "money" is set in order to achieve a monetary policy objective. This direct relationship between money and monetary policy generates the tensions that we discuss in Section 3.

[6] See Hamilton (1997), Carpenter and Demiralp (2006a), and Thornton (2006) for empirical evidence of this liquidity effect.

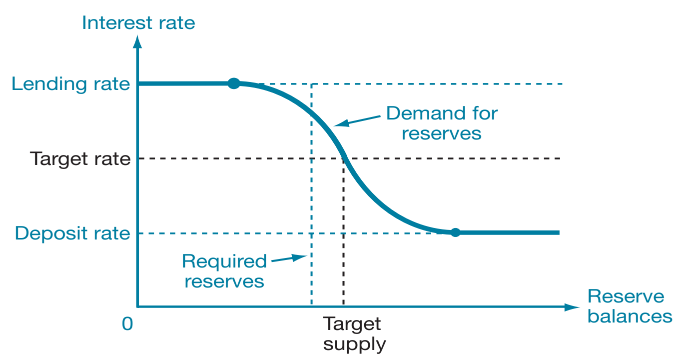
[7] See Ennis and Keister (2008) for a detailed discussion of interest rate volatility in this basic framework. See Whitesell (2006a) for a formal model of the "flattening" effect of reserve maintenance periods.

2.2 Symmetric Channel Systems

Many central banks use what is known as a symmetric *channel* (or *corridor*) system for monetary policy implementation. Such systems are used, for example, by the European Central Bank (ECB) and by the central banks of Australia, Canada, England, and (until spring 2006) New Zealand. The key features of a symmetric channel system are standing central bank facilities that lend to and accept deposits from commercial banks. The lending facility resembles the discount window in the United States; banks are permitted to borrow freely (with acceptable collateral) at an interest rate that is a fixed number of basis points above the target rate. The deposit facility allows banks to earn overnight interest on their excess reserve holdings at a rate that is the same number of basis points below the target. In this way, the interest rates at the two standing facilities form a "channel" around the target rate.

Exhibit 2 depicts the demand for reserve balances in a symmetric channel system. The curve looks very similar to that in Exhibit 1. There is no demand for reserves in the interbank market if the interest rate is higher than the rate at the lending facility.[8] For lower values of the market rate, the demand is decreasing in the interest rate—and hence the liquidity effect is present—for exactly the same reasons as before. Banks choose their reserve holdings to balance the potential costs of falling short of their requirement against the potential costs of ending with excess reserves. When the opportunity cost of holding reserves is lower, banks' precautionary demand for reserves will be larger.

Exhibit 2
A Symmetric Channel System of Monetary Policy Implementation



[8] The lending facility in a channel system is typically designed in a way that aims to minimize stigma effects. For this reason, we begin the demand curve in Exhibit 2 at the lending rate instead of at a penalty rate that includes stigma effects, as was the case in Exhibit 1.

The new feature in Exhibit 2 is that the demand curve does not decrease all the way to the horizontal axis, but instead becomes flat at the deposit rate. In other words, the deposit rate forms a *floor* below which the demand curve will not fall. If the market rate were below the deposit rate, an arbitrage opportunity would exist—a bank could borrow at the (low) market rate and earn the (higher) deposit rate on these funds, making a pure profit. The demand for reserves would be unbounded in this case; such arbitrage activity would quickly drive up the market rate until it at least equals the deposit rate.

The demand curve is flat at the deposit rate for the same reason it was flat on the horizontal axis in Exhibit 1. If the market rate were exactly equal to the deposit rate, banks would face no opportunity cost of holding excess reserves. Holding additional funds on deposit and lending them would yield exactly the same return. Banks would therefore be indifferent between any quantities of reserves above the fully insured amount. In other words, paying interest on excess reserves raises the floor where the demand curve is flat from an interest rate of zero (as in Exhibit 1) to the deposit rate (as in Exhibit 2).

> *[In a symmetric channel system,] the target interest rate determines, through the demand curve, a target supply of reserves, and the central bank aims to change total reserve supply to bring it as close as possible to this target.*

The equilibrium interest rate is determined exactly as before, by the height of the demand curve at the level of reserve balances supplied by the central bank. Monetary policy is thus implemented in much the same way as it is in the United States. The target interest rate determines, through the demand curve, a target supply of reserves, and the central bank aims to change total reserve supply to bring it as close as possible to this target. Importantly, the link between money and monetary policy remains: the quantity of reserves is set in order to achieve the desired interest rate.

The symmetric channel systems used by various central banks differ in a variety of important details. The Bank of England and the ECB operate relatively wide channels, with the standing facility rates 100 basis points on either side of the target. Australia and Canada, in contrast, operate narrow channels, where this figure is only 25 basis points. Australia and Canada have no required reserves; in this case, the demand curve in Exhibit 2 shifts to the left so that the "required reserves" line lies on the vertical axis. The important point here, however, is that regardless of these operational details, a symmetric channel system links the quantity of reserves to the central bank's interest rate target, exactly as in the U.S. system.

3. Payments, Liquidity Services, and Reserves

The link between money and monetary policy described above can generate tension with central banks' other objectives, particularly those regarding the payments system and the provision of liquidity. Reserve balances are useful to banks, and to the financial system more generally, for purposes other than simply meeting reserve requirements. Banks use reserve balances to provide valuable payment services to depositors. In addition, these balances assist the financial sector in allocating other, less liquid assets. Since reserves are a universally accepted asset, they can be exchanged more easily for other assets than any substitute. Finally, reserve balances serve as a perfectly liquid, risk-free store of value, which is particularly useful during times of market turmoil. Because reserves play these other important roles, the quantity of reserve balances consistent with the central bank's monetary policy objective may at times come into conflict with the quantity that is desirable for other purposes. In this section, we describe some of the tensions that can arise.

3.1 Payments Policy

The value of the payments made during the day in a central bank's large-value payments system is typically far greater than the level of reserve balances held by banks overnight. (In the United States, for example, during the first quarter of 2008 the average daily value of transactions over the Fedwire Funds Service was approximately *185 times* the value of banks' total balances on deposit at the Federal Reserve.) The discrepancy has widened in recent decades as most central banks have adopted a real-time gross settlement (RTGS) design for their large-value payments system, which requires substantially larger payment flows than earlier designs based on netting of payment values.[9]

As a result, banks' overnight reserve holdings are too small to allow for the smooth functioning of the payments system

[9] See Bech and Hobijn (2007) for an analysis of the adoption of RTGS systems by various central banks.

during the day. When reserves are scarce or costly during the day, banks must expend resources in carefully coordinating the timing of their payments. If banks delay sending payments to economize on scarce reserves, the risk of an operational failure or gridlock in the payments system tends to increase. The combination of limited overnight reserve balances and the much larger daylight demand for reserves thus creates tension between a central bank's monetary policy and its payments policy. The central bank would like to increase the total supply of reserve balances for payment purposes, but doing so would interfere with its monetary policy objectives.

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This tension has led to a common practice among central banks of supplying additional reserves to the banking system for a limited time during the day. These daylight reserves (also called *daylight credit*) are typically lent directly to banks. Many central banks provide daylight reserves against collateral at no cost to banks. The Federal Reserve currently supplies daylight credit to banks on an uncollateralized basis for a small fee.[10] In providing daylight reserves, a central bank aims to allow banks to make their payments during the day smoothly and efficiently while limiting its own exposure to credit risk.

Under normal circumstances, this process of expanding the supply of reserves during the day and shrinking it back overnight works well; banks make payments smoothly and the central bank implements its target interest rate. However, this balancing act is not without costs. Lending large quantities of reserves to banks each day exposes the central bank to credit risk. While requiring collateral for these loans mitigates credit risk, it is an imperfect solution. If collateral is costly for banks to hold or create, the requirement imposes real costs. Moreover, collateralizing daylight loans simply moves the central bank's claims ahead of the deposit insurance fund in the event of a bank failure, without necessarily reducing the overall risk of the consolidated public sector.

Routine daylight lending by the central bank may also create moral hazard problems, leading banks to hold too little liquidity and, perhaps, take on too much risk. In addition, such lending might make regulators more reluctant to close a financially troubled bank promptly, exacerbating the well-known too-big-to-fail problem. Even if each of these costs is relatively small in normal times, their sum should be considered part of the tension generated by the link between money and monetary policy.

3.2 Liquidity Policy

In times of stress or crisis in financial markets, the tension between monetary policy and central banks' other objectives can become acute. After the destructive events of September 11, 2001, the Federal Reserve recognized that the quantity of overnight reserves consistent with the target fed funds rate was too small to adequately address banks' reluctance to make payments in a timely manner. The FOMC released a statement on September 17, 2001, that, in addition to lowering the target fed funds rate, stated:

> The Federal Reserve will continue to supply unusually large volumes of liquidity to the financial markets, as needed, until more normal market functioning is restored. As a consequence, the FOMC recognizes that the actual federal funds rate may be below its target on occasion in these unusual circumstances.[11]

In this statement, the FOMC explicitly recognized the tension between maintaining the market interest rate at its target level and supplying more reserves to meet the demand for financial market settlements. On September 18 and 19, the effective fed funds rate was close to 1¼ percent while the target rate was 3 percent.

Exhibit 1 is again useful to help illustrate what happened. To meet the demand for reserves for financial settlements in various markets, the Fed increased the supply of reserve balances. A shift in the supply curve to the right implies that intersection with the demand curve will occur at a lower interest rate.[12] In this case, it was not possible to achieve simultaneously the interest rate target and the increase in overnight reserves necessary to ensure the efficient functioning

[10] See Board of Governors of the Federal Reserve System (2008b) for a proposal to change the Federal Reserve's method of supplying daylight reserves. Under this proposal, banks would be able to obtain daylight reserves either on a collateralized basis at no cost or on an uncollateralized basis for a higher fee. For a general discussion of the Federal Reserve's policies on daylight credit, see Board of Governors of the Federal Reserve System (2007).

[11] See <http://www.federalreserve.gov/boarddocs/press/general/2001/20010917>.

of financial markets in conditions of stress. The exact same tension would arise under a symmetric channel system. Note, however, that the channel places a limit on how far the market interest rate can deviate from the target—it cannot fall below the deposit rate.

During the events of September 2001, the fed funds rate was below its target for only a few days and thus likely had no impact on monetary policy objectives, as expectations were that the target rate would quickly be reestablished. It is an instructive episode, however, in that it demonstrates how increasing the supply of reserve balances available to the banking system can support market liquidity, and how this objective can interfere with the maintenance of the target interest rate.

The Federal Reserve faced a different type of liquidity issue during the financial market turmoil that began in August 2007. In this case, there was a sharp decline in . . . broad liquidity*: the ease with which assets in general can be sold or used as collateral at a price that appropriately reflects the expected value of the asset's future dividends.*

The Federal Reserve faced a different type of liquidity issue during the financial market turmoil that began in August 2007. In this case, there was a sharp decline in what Goodfriend (2002) calls *broad liquidity*: the ease with which assets in general can be sold or used as collateral at a price that appropriately reflects the expected value of the asset's future dividends. Goodfriend argues that increasing the supply of bank reserves can also support the level of broad liquidity in financial markets. This is especially true if the central bank uses the newly created reserves to purchase (or lend against) relatively illiquid assets, thereby increasing the total quantity of liquid assets held by the private sector. However, once again the link between money and monetary policy generates a tension; the central bank cannot pursue an independent "liquidity policy" using bank reserves. Any attempt to increase reserve balances for the purpose of providing additional liquidity would lead to a lower short-term interest rate and, hence, would change the stance of monetary policy.

Goodfriend (2002, p. 4) points out that central banks can use other, less direct methods of managing broad liquidity:

> To some degree, the Fed can already manage broad liquidity under current operating procedures by changing the composition of its assets, for example, by selling liquid short-term Treasury securities and acquiring less liquid longer term securities. However, the government debt injected into the economy in this way would not be as liquid as newly created base money. More importantly, the Fed's ability to affect broad liquidity in this way is strictly limited by the size of its balance sheet.

Interestingly, one of the new facilities introduced by the Fed in response to the market turmoil closely resembled the policy described by Goodfriend. The Term Securities Lending Facility, introduced in March 2008, provides loans of Treasury securities using less liquid assets as collateral.[13] These loans increase broad liquidity by raising the total supply of highly liquid assets (reserves plus Treasury securities) in the hands of the private sector and decreasing the supply of less liquid assets. However, as Goodfriend observes, the amount of broad liquidity that can be provided through such a facility is strictly limited by the quantity of Treasury securities owned by the central bank. Thus, while a central bank can pursue a policy based on changes in the composition of its assets, such a policy has inherent limitations. As we discuss in Section 4, alternative methods of monetary policy implementation allow the central bank to overcome this limitation by pursuing a liquidity policy based directly on bank reserves.

3.3 Efficient Allocation of Resources

Another tension generated by the typical methods of monetary policy implementation described earlier relates to efficiency concerns. These methods rely on banks facing an opportunity cost of holding reserves; their balances earn no interest in the U.S. system and earn less than the prevailing market rate in a symmetric corridor. This opportunity cost helps generate the downward-sloping part of the demand curve that the central bank uses to implement its target interest rate. The fact that

[12] Needless to say, the disruption in financial markets would also tend to increase the demand for reserves, shifting the curve in Exhibit 1 to the right. The FOMC's statement indicates a desire to more than compensate for this shift, that is, to increase reserve supply beyond the point that would maintain the target interest rate given the increased reserve demand.

[13] The Fed also introduced other facilities, including the Term Auction Facility and the Primary Dealer Credit Facility. Those facilities make loans of reserve balances. In order to maintain the target interest rate, however, the Fed uses open market operations to "sterilize" these loans, leaving the total supply of reserve balances unaffected.

holding reserves is costly, however, conflicts with another central bank objective: the desire to promote the efficient functioning of financial markets and the efficient allocation of resources more generally.

Remunerating reserve balances at a below-market interest rate is effectively a tax on holding these balances. (Box 1 discusses how this tax is distortionary when applied to required reserves.) Similar logic shows that a distortion arises when banks face an opportunity cost of holding *excess* reserves. In this case, the tax leads banks to invest real resources in economizing on their holdings of excess reserves, but these efforts produce no social benefit.

Reserve balances are costless for a central bank to create through open market operations, for example, that exchange newly created reserves for Treasury securities. If banks perceive an opportunity cost of holding reserves (relative to Treasury securities, say), then they will engage in socially inefficient efforts to reduce their use of reserves. In other words, the tax places a wedge between a private marginal rate of substitution and the corresponding social marginal rate of transformation. This type of distortion was emphasized by Friedman (1959, pp. 71-5), who argues that the central bank should pay interest on all reserve balances at the prevailing market interest rate.[14]

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One might be tempted to suppose that the distortions created by this tax must be small because the quantity of excess reserves held by banks is currently fairly small in the United States, around $1.5 billion. Such a conclusion is not warranted, however: the fact that the tax base is small does not imply that the deadweight loss associated with the tax is insignificant. The deadweight loss includes all efforts banks expend to avoid holding excess reserves, including closely monitoring end-of-day and end-of-maintenance-period balances so that any

[14] This logic is central to the well-known *Friedman rule*, which calls for the central bank to eliminate the opportunity cost of holding all types of money (see especially Friedman [1969]). One way to implement this rule is by engineering a deflation that makes the real return on holding currency equal to the risk-free return. In this case, no interest needs to be paid on any form of money; the deflation generates the required positive return. In practice, there are a variety of concerns about deflation that keep central banks from following this approach. When applied to the narrower question of reserve balances held at the central bank, however, Friedman's logic simply calls for remunerating all reserve balances at the risk-free rate.

Box 1

Required Reserves

Although this article emphasizes the similarities in monetary policy implementation procedures across countries, there are a number of differences. One notable difference is in the use of reserve requirements. Banks in the United States and the Euro zone are required to hold reserves in proportion to certain liabilities. In other countries, including Australia and Canada, banks are not required to hold any reserves; the only requirement is that a bank's reserve account not be in overdraft at the end of the day.

In the simple framework we describe, it is immaterial whether banks face a positive reserve requirement or the requirement is effectively zero. In reality, however, there are important differences between these approaches. One such difference is that reserve requirements allow the central bank to implement reserve averaging, whereby banks are allowed to meet their requirement on average over a reserve maintenance period rather than every day. As shown in Whitesell (2006a), reserve averaging tends to flatten the demand curve for reserves around the central bank's target supply on all days of a maintenance period except the last one; this flattening tends to reduce volatility in the market interest rate.[a] Another important difference is the extent of the distortions associated with bank reserve holdings. When required reserve balances do not earn interest, as is currently the case in the United States, the requirement acts as a tax on banks. This *reserve tax* raises banks' operating costs and drives a wedge between the price of banking services and the social cost of producing those services, creating a deadweight loss. The reserve tax also gives banks a strong incentive to find ways to decrease their requirements, such as by sweeping customers' checking account balances on a daily basis into other accounts not subject to reserve requirements. The efforts invested in these reserve-avoidance activities are clearly wasted from a social point of view.

Paying interest on required reserves at the prevailing market rate of interest, as the European Central Bank does, eliminates most of these distortions. The Bank of England goes a step further by having banks set *voluntary* balance targets. Once set, these targets can be used to implement monetary policy exactly the same way that reserve requirements are. However, because the targets are chosen by the individual banks, rather than being determined administratively, their creation generates none of the distortions associated with traditional reserve requirements.

[a] See Ennis and Keister (2008) for a detailed discussion of reserve averaging in the type of framework used here.

excess funds can be lent out, as well as actually lending the funds out. A substantial fraction of activity in the fed funds market is precisely of this type, and it is not clear whether these indirect costs associated with the tax are small.

The issues created by the reserve tax are sometimes described as a "hot potato" problem. Participants all try to get rid of excess reserves because holding them is costly. However, the supply of excess reserve balances is fixed by the central bank and, at any point in time, someone must be holding them. Extending this analogy a bit, the fact that the potato itself (that is, the quantity of excess reserve balances) is small does not imply that that the efforts spent passing it along are also small. This is especially true if the potato is very hot, that is, if excess reserve balances earn much less than the market rate of interest.

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Lucas (2000, p. 247) describes the deadweight loss associated with the inflation tax in a similar way:

> In a monetary economy, it is in everyone's private interest to try to get someone else to hold non-interest-bearing cash and reserves. But someone has to hold it all, so all of these efforts must simply cancel out. All of us spend several hours per year in this effort, and we employ thousands of talented and highly trained people to help us. These person-hours are simply thrown away, wasted on a task that should not have to be performed at all.

Any system of monetary policy implementation that relies on banks facing an opportunity cost of holding reserves necessarily creates deadweight losses. The approaches described in the previous section thus conflict with a central bank's desire to promote an efficient allocation of resources in the economy.

We summarize by noting that a central bank's payments policy, liquidity policy, and desire to promote efficient allocation may all come into conflict with its monetary policy objectives. The tension created by these conflicts tends to be particularly strong during periods of stress in financial markets. These tensions would be reduced or would disappear altogether if banks did not face an opportunity cost of holding overnight reserves that leads them to economize on their holdings. In the next section, we describe an approach to implementing monetary policy that removes this opportunity cost and discuss some of its implications.

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4. Divorcing Money from Monetary Policy

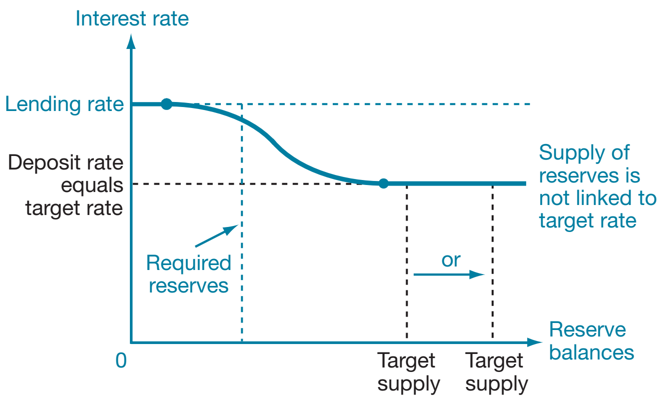
The tensions we described all arise from the fact that, under either current U.S. practice or a symmetric channel system, the quantity of reserve balances must be set to a particular level in order for the central bank's interest rate target to be achieved. There are, however, other approaches to monetary policy implementation in which this strict link between money and monetary policy is not present. Here we discuss one such approach, which can be described as a *floor-target channel system*, or simply a *floor system*. This approach is a modified version of the channel system described above and has been advocated in various forms by Woodford (2000), Goodfriend (2002), Lacker (2006), and Whitesell (2006b). A particular type of floor system has recently been adopted by the Reserve Bank of New Zealand.

4.1 The Floor System

Starting from the symmetric channel system presented in Exhibit 2, suppose that the central bank makes two

Exhibit 3

A Floor System of Monetary Policy Implementation



modifications. First, the deposit rate is set *equal to* the target rate, instead of below it. In other words, in this system the central bank targets the *floor* of the channel, rather than some point in the interior. Second, the reserve supply is chosen so that it intersects the flat part of the demand curve generated by the deposit rate (Exhibit 3), rather than intersecting the downward-sloping part of the curve. Supply and demand will then cross exactly at the target rate, as desired.[15]

The key feature of this system is immediately apparent in the exhibit: the equilibrium interest rate no longer depends on the exact quantity of reserve balances supplied. Any quantity that is large enough to fall on the flat portion of the demand curve will implement the target rate. In this way, a floor system "divorces" the quantity of money from the interest rate target and, hence, from monetary policy. This divorce gives the central bank two separate policy instruments: the interest rate target can be set according to the usual monetary policy concerns, while the quantity of reserves can be set independently.

If the quantity of reserves is no longer determined by monetary policy concerns, how should it be set? In general, the supply of overnight reserve balances could be used to ease any of the tensions described earlier. For example, Lacker (2006) suggests that increasing the supply of overnight reserves could reduce banks' use of daylight credit without impairing their ability to make timely payments. In fact, he argues that if overnight reserve balances are increased by the maximum amount of current daylight credit use, then "in principle, any pattern of intraday payments that is feasible under the current policy would still be feasible" even in the extreme case where access to daylight credit is eliminated altogether. Note that restricting access to daylight credit will tend to increase the demand for overnight reserves, shifting the curve in Exhibit 3 to the right. The proposal in Lacker (2006) thus calls for increasing the supply of reserves enough to ensure that it falls on the flat portion of the demand curve even after this shift is taken into account.[16]

Goodfriend (2002) takes a different view, proposing that the supply of reserve balances could be used to stabilize financial markets. The central bank could, for example, "increase bank reserves in response to a negative shock to broad liquidity in banking or securities markets or an increase in the external finance premium that elevated spreads in credit markets" (p. 4). More generally, he suggests that the supply of reserves could be set to provide the optimal quantity of broad liquidity services.[17] It should be noted that there may be complementarity between payments policy and liquidity policy with respect to reserve balances; increasing the reserve supply to support broad liquidity can simultaneously reduce the use of daylight overdrafts, which might be particularly desirable during times of market turmoil.

A floor system "divorces" the quantity of money from the interest rate target and, hence, from monetary policy. This divorce gives the central bank two separate policy instruments: the interest rate target can be set according to the usual monetary policy concerns, while the quantity of reserves can be set independently.

The floor system also promotes a more efficient allocation of resources. Not only does this approach eliminate the reserve tax, it also removes the opportunity cost of holding *excess*

[15] The fact that these supply and demand curves cross at the target rate does not imply that trades in the interbank market would occur at exactly this rate. A bank would require a small premium, reflecting transaction costs and perhaps credit risk, in order to be willing to lend funds rather than simply hold them as (interest-bearing) reserves. As a result, the measured interest rate in the interbank market would generally be slightly above the deposit rate. The target rate could instead be called the *policy rate* in order to make this distinction clear.

[16] See Ennis and Weinberg (2007) for a formal analysis of the relationship between daylight credit and monetary policy implementation, including the ability of a floor system to reduce daylight credit usage.

[17] Determining this optimal quantity is a nontrivial task, however, and would likely require more research on the notion of broad liquidity and its role in the macroeconomy. The quantitative easing policy in place in Japan from 2001 to 2006 can be viewed as an attempt to use the supply of bank reserves to influence macroeconomic outcomes.

reserve balances. This is true for any quantity of reserve balances large enough to lie on the flat portion of the demand curve in Exhibit 3. At such points, banks are indifferent at the margin between reserves and other risk-free assets. As a result, they no longer have an incentive to invest real resources in order to economize on their reserve holdings, and the deadweight loss associated with the systems described in Section 3 disappears.

Woodford (2000) points to another advantage of the floor system. Suppose that innovation in financial markets were to undermine the demand for reserve balances that is at the heart of our model in Section 2. In particular, suppose that a perfect substitute for central bank reserves were developed and that banks were able to avoid reserve requirements completely. In such a situation, the demand for reserves would fall to zero if there were *any* opportunity cost of holding them; banks would instead use the substitute private instrument for payment and other liquidity purposes. If the central bank supplied a positive quantity of reserves, under the current system in the United States the market interest rate would fall to zero.

The Reserve Bank of New Zealand recently became the first central bank to implement a floor system. While it is too early to evaluate the effects of this change properly, some benefits—such as improved timeliness of payments—have already been observed.

Woodford argues that even in this extreme situation, the central bank can still implement its target interest rate by using a floor system. Banks would again demand zero reserves at any interest rate higher than the target rate in this situation. However, under a floor system, the demand curve would be flat at the target rate for exactly the same reasons as described above. By setting a positive supply of reserves, therefore, the central bank could still drive the market interest rate to the target value. In this way, a floor system would enable the central bank to meet its monetary policy objectives even if technological changes eliminated the special role currently played by reserves; the key once again is divorcing money from monetary policy.

The Reserve Bank of New Zealand recently became the first central bank to implement a floor system (Box 2). While it is too early to evaluate the effects of this change properly, some benefits—such as improved timeliness of payments—have already been observed. To be sure, the experience of a smaller country like New Zealand with this type of system may not be directly applicable to other central banks. Nevertheless, it will be instructive to observe this experience and, in particular, to see how it compares with the simple framework we present.

4.2 Discussion

While a floor system could potentially relieve or even eliminate the tensions between central bank objectives, there are several important concerns about how such a system would operate in practice and its potential effects on financial markets. One concern is that a floor system would likely lead to a substantial reduction in activity in the overnight interbank market, as banks would have less need to target their reserve balance precisely on a daily basis. In particular, since banks with excess funds can earn the target rate by simply depositing them with the central bank, the incentive to lend these funds is lower than it is under the other approaches to implementation discussed above. Nevertheless, an interbank market would still be necessary, as institutions will occasionally find themselves short of funds. How difficult it would be for institutions to borrow at or near the target rate is an important open question.

In addition, some observers argue that the presence of an active overnight market generates valuable information and that some of this information would be lost if market activity declined. For example, market participants must monitor the creditworthiness of borrowers. If the overnight market were substantially less active, such monitoring may not take place on a regular basis; this in turn could make borrowing even harder for a bank that finds itself short of funds. Such monitoring may also play a socially valuable role in exposing banks to market discipline. It is important to bear in mind, however, that the

While a floor system could potentially relieve or even eliminate the tensions between central bank objectives, there are several important concerns about how such a system would operate in practice and its potential effects on financial markets.

Box 2

The Reserve Bank of New Zealand's Floor System

In July 2006, the Reserve Bank of New Zealand (RBNZ) began the transition from a symmetric channel system of monetary policy implementation to a floor system. We describe some reasons for the change and some features of the new regime, drawing heavily on Nield (2006) and Nield and Groom (2008).

From 1999 to 2006, the RBNZ operated a symmetric channel system with zero reserve requirements. It targeted a supply of NZD 20 million overnight reserve balances every day. All reserve balances were remunerated at a rate 25 basis points below the RBNZ's target interest rate, called the official cash rate (OCR). Payments system participants could borrow reserves overnight against collateral at the overnight reserve repurchase facility (ORRF), at a rate 25 basis points above the OCR. Finally, participants could obtain reserves intraday, against collateral, at an interest rate of zero using a facility called Autorepo.

The RBNZ's decision to change the framework for monetary policy implementation followed signs of stress in the money market. The Government of New Zealand had been running a fiscal surplus for a number of years and government bonds had become increasingly scarce. The scarcity of government securities available to pledge in the Autorepo facility led to delayed payments between market participants. For the same reason, there had been an increase in the levels of underbid open market operations and, consequently, in the use of the bank's standing facilities at the end of the day. Finally, the implied New Zealand dollar interest rates on overnight credit in the foreign exchange (FX) swap market—the primary market by which banks in New Zealand traded overnight—were volatile and often significantly above the target rate desired to implement monetary policy.

The Reserve Bank of New Zealand conducted a review of its liquidity management regime in 2005 and announced the new system in early 2006. Under this system, the RBNZ no longer offers daylight credit. In other words, there is no distinction between daylight and overnight reserves. The target supply of reserves has been vastly increased to allow for the smooth operation of the payments system; the new level currently fluctuates around NZD 8 billion. This represents an increase of 400 times the level under the previous regime. Reserves are now remunerated at the OCR. It is still possible to obtain overnight funds at the ORRF, but at a rate 50 basis points above the OCR.

The bulk of the transition to this new system occurred in four steps over a twelve-week period between July 3 and October 5, 2006. During that time, the target supply of reserves increased gradually to its current level. At each step, the rate earned on reserves and the rate at which funds could be borrowed at the ORRF were increased relative to the OCR in increments of 5 basis points up to their current levels. The set of securities eligible as collateral for Autorepo was reduced until the facility was discontinued on October 5.

Since the new framework was introduced, the RBNZ has implemented two changes. First, banks are now allowed to use a wider set of assets to raise cash from the central bank. In particular, a limited amount of AAA-rated paper is eligible.[a] Second, a tiered system of remuneration was introduced in response to episodes in which the market interest rate rose substantially above the OCR. The RBNZ now estimates the quantity of reserves a bank needs for its payment activity and, based on this estimate, sets a limit on the quantity that will be remunerated at the OCR. Any reserves held in excess of that limit earn a rate 100 basis points below the OCR. This policy is designed to provide an incentive for banks to recirculate excess reserve positions and to prevent them from "hoarding" reserves.

In principle, the RBNZ could have addressed this problem by increasing its supply of reserves instead of by implementing a tiered system. If the market interest rate is significantly higher than the policy rate in a floor system, increasing the supply of reserves should drive the market rate down (see Exhibit 3 in the text). However, the RBNZ uses FX swaps to increase the supply of reserves, and it found that the price in this market was moving against it; the more reserves the RBNZ created, the more costly it became to create those reserves. It is worth noting that this problem would not arise in a country with a large supply of government bonds or with a central bank that can issue its own interest-bearing liabilities. In such cases, increasing the supply of reserves need not be costly and could be an attractive alternative to a tiered system.

While it is too early to evaluate with great confidence all of the effects of the RBNZ's changes, it appears that the transition went smoothly overall. There were, of course, occasional signs of stress in money markets, mostly attributable to the learning process experienced by the Bank and its payments system participants. There are, however, definite positive signs that the liquidity of the interbank market has improved. Notably, payments have been settling significantly earlier since the transition began, suggesting a reduction in the constraints previously attributable to the scarcity of collateral available to pledge in the Autorepo facility. In addition, the implied New Zealand dollar interest rates in the FX swap market are now much less volatile and are well within the 50 basis point band between the official cash rate and the ORRF. Finally, the RBNZ conducts open market operations much less frequently, and the operations are no longer subject to the underbidding that had led to excessive use of overnight facilities.

[a] See the Reserve Bank of New Zealand's May 2008 Financial Stability Report for more details.

market for overnight loans of reserves differs from other markets in fundamental ways. As we discussed, reserves are not a commodity that is physically scarce; they can be costlessly produced by the central bank from other risk-free assets. Moreover, there is no role for socially useful price discovery in this market, because the central bank's objective is to set a particular price. Weighing the costs and benefits of a reduction in market activity is therefore a nontrivial task and an important area for future research.

If desired, the floor system could be modified in ways that encourage higher levels of activity in the overnight interbank market. For example, the central bank could limit the quantity of reserves on which each bank earns the target rate of interest and compensate balances above this limit at a lower rate. Such limits would encourage banks that accumulate unusually large balances over the course of the day to lend them out. By setting lower limits, the central bank would encourage more activity in the interbank market while marginally increasing the distortions discussed above.[18] Whitesell (2006b) presents a system in which banks are allowed to determine their own limits by paying a "capacity fee" proportional to the chosen limit. In this case, the central bank would set the fee schedule in a way that balances concerns about the level of market activity with the resulting level of distortions.

If desired, the floor system could be modified in ways that encourage higher levels of activity in the overnight interbank market.

Another interesting issue is the extent to which a floor system would allow the central bank to restrict access to daylight credit, if it so desired. If access to daylight credit is substantially restricted or removed, the smooth functioning of the payments system may require banks to acquire funds in the market on a timely basis during the day. In principle, this could be accomplished by the development of either an intraday market for reserve balances or a market for precise time-of-day delivery of reserves (see McAndrews [2006] for a discussion of such possibilities). Whether such markets would actually develop and how efficiently they would operate are important open questions.

Going forward, the experience of New Zealand's floor system will provide valuable information on these issues and others that might arise. However, the differences between the financial system of New Zealand and those of economies like the United States will make it difficult to draw definite conclusions. For this reason, it is important to employ the tools of modern economic theory to develop models that are capable of addressing these issues.

5. Conclusion

This article highlights the important similarities in the monetary policy implementation systems used by many central banks. In these systems, there is a tight link between money and monetary policy because the supply of reserve balances must be set precisely in order to implement the target interest rate. This link creates tensions with the central bank's other objectives. For example, the intraday need for reserves for payment purposes is much higher than the overnight demand, which has led central banks to provide low-cost intraday loans of reserves to participants in their payments systems. This activity exposes the central bank to credit risk and may generate problems of moral hazard. The link also prevents central banks from increasing the supply of reserves to promote market liquidity in times of financial stress without compromising their monetary policy objectives. Furthermore, the link relies on banks facing an opportunity cost of holding reserves, which generates deadweight losses and hinders the efficient allocation of resources.

Our study also presents an approach to implementing monetary policy in which this link is severed, leaving the quantity of reserves and the interest rate target to be set independently. In this floor-system approach, interest is paid on reserve balances at the target interest rate. This policy allows the central bank to increase the supply of reserves, perhaps even significantly, without affecting the short-term interest rate. While the floor system has received a fair amount of attention in policy circles recently, there are important open questions about how well such a system will work in practice. Going forward, it will be useful to develop theoretical models of the monetary policy implementation process that can address these questions, as well as to observe New Zealand's experience with the floor system it implemented in 2006.

[18] Ennis and Keister (2008) describe a related approach based on "clearing bands," where banks face a minimum requirement and earn the target rate of interest on balances held up to a higher limit. This approach could be used to encourage activity in the interbank market on the borrowing side (by banks that find themselves below the minimum requirement) as well as on the lending side (by banks that find themselves above the higher limit).

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