Financial Intermediation and Macroeconomic Analysis

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I ssues relating to financial stability have always been part of the macroeconomics curriculum, but they have often been presented as mainly of historical interest, or primarily of relevance to emerging markets. However, the recent financial crisis has made it plain that even in economies like the United States, significant disruptions of financial intermediation remain a possibility. Understanding such phenomena and the possible policy responses requires the use of a macroeconomic framework in which financial intermediation matters for the allocation of resources.

In this paper, I first discuss why neither standard macroeconomic models that abstract from financial intermediation nor traditional models of the "bank lending channel" are adequate as a basis for understanding the recent crisis. I argue that instead we need models in which intermediation plays a crucial role, but in which intermediation is modeled in a way that better conforms to current institutional realities. In particular, we need models that recognize that a market-based financial system—one in which intermediaries fund themselves by selling securities in competitive markets, rather than collecting deposits subject to reserve requirements—is not the same as a frictionless system.

I then sketch the basic elements of an approach that allows financial intermediation and credit frictions to be integrated into macroeconomic analysis in a straightforward way. I show how the model can be used to analyze the macroeconomic consequences of the recent financial crisis and conclude with a discussion of some implications of the model for the conduct of monetary policy.

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Why a New Framework for Macroeconomic Analysis is Needed

It may be useful first to review why familiar macroeconomic models do not already incorporate the features needed to make sense of recent economic developments. I shall argue that it is difficult to understand why either the significant decline in house prices since 2006 or the substantial losses sustained by financial firms should have so seriously affected aggregate employment and economic activity except in the context of a model in which financial intermediaries play a crucial role and in which their ability to fulfill that function can at some times be significantly impaired.

Housing Prices and Aggregate Demand

While the severity of the recent financial crisis has been extensively discussed, some have questioned whether it was really the primary cause of the Great Recession. For example, Baker (2010) argues that a substantial reduction in aggregate demand can be explained as a wealth effect on consumer expenditure, given the decline in U.S. households' housing wealth by several trillion dollars. In this analysis, "the problem is not first and foremost a financial crisis." But as Buiter (2010) points out, there is no aggregate wealth effect of a decline in housing prices, since the household sector in aggregate is both the owner of the housing stock and the consumer of the services supplied by it. A fall in house prices reduces the value of an asset, but also reduces the cost of buying the stream of housing services that people were planning to purchase by exactly the same amount.

It is possible to have a nonzero effect on aggregate expenditure on other goods (when other prices remain unchanged), even without financial frictions, owing to redistribution of wealth between households with a net "long" position in housing and those with net "short" positions, if the average marginal propensities to consume out of wealth are different between the two types. Nonetheless, because the positive and negative wealth effects will largely offset one another, the effect on aggregate demand is likely to be fairly small relative to the size of the aggregate decrease in housing wealth.

Larger effects are instead possible if one recognizes that the losses resulting from the collapse of housing prices were disproportionately concentrated in certain financial institutions which play a role in the allocation of resources that cannot easily be replaced by those to whom wealth was redistributed. A model of this kind is sketched below. For a quantitative analysis of the effects of the fall in U.S. housing prices that stresses such effects, see Greenlaw, Hatzius, Kashyap, and Shin (2008).

Banking and the Money Supply

It is also difficult to understand why large losses by financial institutions on housing-related bets should have such a significant effect on the real economy without a model that takes account of credit frictions. According to the well-known monetarist view, banking crises affect the economy because they reduce the total supply of money in the economy, since the "money multiplier"—the factor by which

the economy's money supply exceeds the "monetary base" supplied by the central bank—falls when funds are withdrawn from commercial banks in response to concerns about their stability. The lower money supply is then only consistent with money demand to the extent that money demand is also reduced, through some combination of lower economic activity and deflation. This is the classic account by Friedman and Schwartz (1963) of how the widespread bank failures in the United States deepened the Great Depression.

However, such a model, at least as conventionally elaborated, cannot explain why the recent problems of the financial sector should have caused a sharp recession, for the Friedman–Schwartz story depends on the monetary base remaining fixed despite a collapse of the money multiplier. But under contemporary institutional arrangements, the Fed automatically adjusts the supply of base money as necessary to maintain its target for the federal funds interest rate; thus, any change in the money multiplier due to a banking crisis should automatically be offset by a corresponding increase in the monetary base, neutralizing any effect on interest rates, inflation, or output.[1]

Moreover, many of the institutions whose failure or near-failure appeared to do the most damage in the recent crisis, such as Lehman Brothers, did not issue liabilities that would count as part of Friedman and Schwartz's measure of the money supply. Under a classic monetarist view, the failure of such institutions should pose no threat to the aggregate economy. (Hence the proposals by some that finance can remain only lightly regulated, as long as commercial banks are strictly excluded from the riskier activities.) But the consequences of the failure of Lehman suggest otherwise.

Models of the Bank Lending Channel

Models that postulate an essential role for banks in financing certain kinds of expenditure are better able to explain how a financial crisis could have such dire consequences for the real economy as we have observed. However, the kinds of financial constraints that were emphasized in many past models of this kind assumed specific institutional forms and regulatory requirements that have become less relevant to the U.S. financial system over time.

Consider, for example, traditional accounts of the "bank lending channel" of the transmission of monetary policy. This argument emphasized the indispensable role of commercial banks as sources of credit for certain kinds of borrowers, in particular those without direct access to capital markets. Deposits were in turn held to be an indispensable source of funding for the lending of commercial banks, and these were subject to legal reserve requirements. To the extent that reserve requirements were typically a binding constraint, a reduction in the supply of reserves by the Federal Reserve would require the volume of deposits to be reduced, which

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[1] For example, in the model without credit frictions expounded in Figure 2 below, a banking panic that reduces the money multiplier will have no effect other than to increase the supply of base money required to implement the central bank reaction function represented by the schedule *MP*.

would in turn require less lending by commercial banks. Bernanke and Blinder (1988) and Kashyap and Stein (1994) offer expositions of this view; Smant (2002) provides a critical review of the literature.

Clearly, the importance of this channel for effects of monetary policy on economic activity depended on the validity of each of the links in the proposed mechanism: that reserve requirements were a binding constraint for many banks; that commercial banks lacked sources of funding other than deposits; that an important subset of borrowers lacked sources of credit other than commercial banks; and that banks lacked opportunities to substitute between other assets and lending to bank-dependent borrowers. Each of these assumptions was less obviously defensible after the financial innovations and regulatory changes of the 1980s and 1990s. Adrian and Shin (forthcoming a, b) discuss the changing structure of the U.S. financial system in more detail.

Nonbank financial intermediaries became increasingly important as sources of credit, particularly as a result of the growing popularity of securitization. Figure 1A shows the contributions of several categories of financial institutions to total net lending in the United States; while commercial banks are clearly still important, they are far from the only important source of credit. More importantly, both the recent lending boom and the more recent financial crisis had more to do with changes in financial flows of several of the other types shown in the figure; for example, lending by issuers of asset-backed securities surged in the period up until the summer of 2007 and then crashed, while lending by market-based mutual funds and other market-based financial intermediaries[2] crashed after the fall of 2008.

Nor are deposits the main source of funding for the financial sector, even in the case of commercial banks. Figure 1B shows the net increase in financial sector liabilities each quarter from several sources. Checkable deposits are only a small part of the sector's financing; moreover, deposits shrank during the years of the lending boom, but have risen again during the crisis—so that neither the growth in credit during the boom nor the contraction of credit in 2008–09 can be attributed to variations in the availability of deposits as a source of financing. Even to the extent that deposits do matter, one may doubt the extent to which the availability of such funding is constrained by reserve requirements, as in recent years these have ceased to be a binding constraint for many banks (for example, see Bennett and Peristiani, 2002).

In response to skepticism about the relevance of the traditional bank lending channel, Bernanke and Gertler (1995) have instead stressed the importance of an alternative "broad credit channel," in which the balance sheets of ultimate borrowers constrain the amount that they are able to borrow; models incorporating such effects include those of Kiyotaki and Moore (1997) and Bernanke, Gertler, and Gilchrist (1999). However, the recent crisis, at least in its initial phase,

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[2] This category includes mutual funds, the government-sponsored enterprises (GSEs), GSE-backed mortgage pools, finance companies, real-estate investment trusts, broker-dealers, and funding corporations. The "market-based financial intermediaries" terminology derives from Adrian and Shin (forthcoming a).
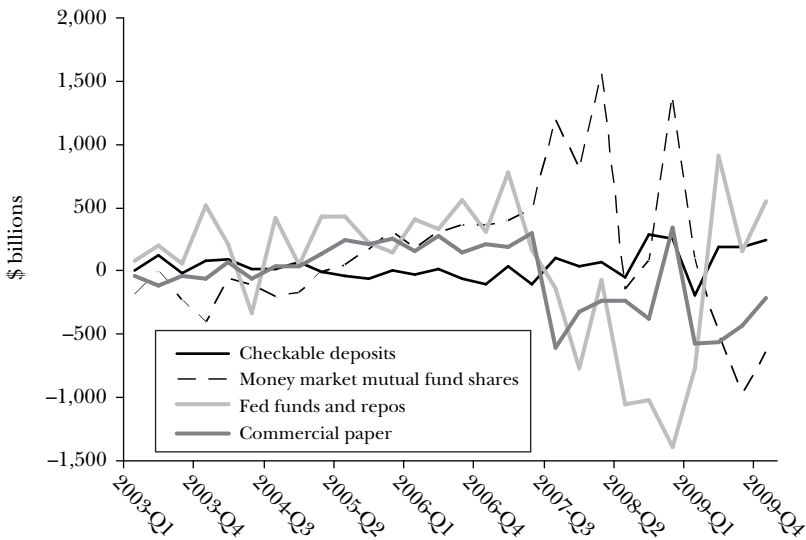
Figure 1
Financial Flows over the Most Recent Credit Cycle

A: Contributions to U.S. Total Net Lending from Several Categories of Financial
Institutions
(*quarterly, in billions of dollars*)
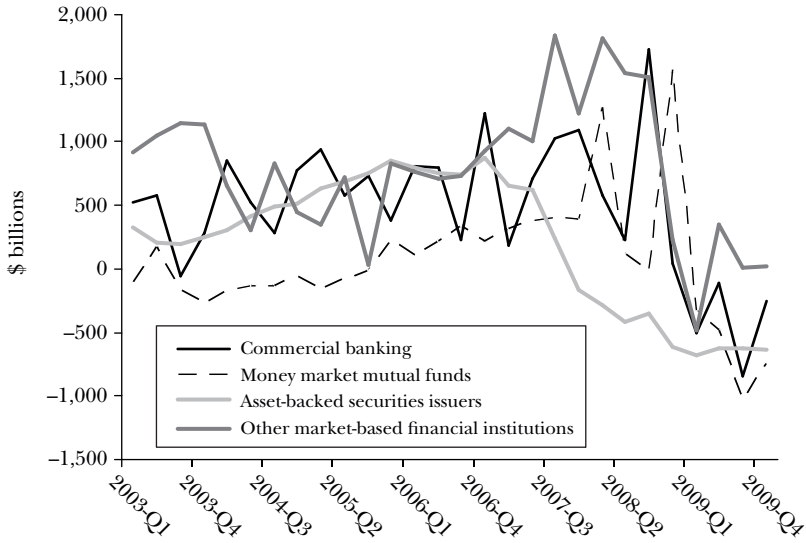
B: Contributions from Several Sources of Funding to the Net Increase in the
Liabilities of the U.S. Financial Sector
(*quarterly, in billions of dollars*)

Source: Federal Reserve Board, Flow of Funds Accounts.

resulted more from obstacles to credit supply, resulting from developments in the financial sector itself, than from a reduction in credit demand owing to the problems of ultimate borrowers.

Hence, what is needed is a framework for macroeconomic analysis in which intermediation plays a crucial role and in which frictions that can impede an efficient supply of credit are allowed for, a framework which also takes account of the fact that the U.S. financial sector is now largely market-based. Fortunately, the development of a new generation of macroeconomic models with these features is now well underway. Adrian and Shin (forthcoming b) and Gertler and Kiyotaki (forthcoming) provide surveys of recent work in this area. Here, I sketch a basic version of such a model, show how it can be used to interpret the recent crisis, and then discuss some implications of a model of this kind for monetary policy. A complete monetary dynamic stochastic general equilibrium model based on the approach sketched here is developed in Cúrdia and Woodford (2009).

Credit and Economic Activity: A Market-Based Approach

The theory sketched here is appropriate to a market-based financial system in which the most important marginal suppliers of credit are no longer commercial banks and in which deposits subject to reserve requirements are no longer the most important marginal source of funding even for commercial banks.

### Macroeconomics with a Single Interest Rate

It is useful to begin by recalling how interest-rate policy affects aggregate activity in a conventional model that abstracts from financial frictions. In the simplest versions of such models, financial conditions can be summarized by a single interest rate, the equilibrium value of which is determined in a market for credit. Figure 2A shows the key equilibrium condition. The loan supply schedule *LS* shows the amount of lending *L* that ultimate savers are willing to finance (by refraining from expenditure themselves) for each possible value of the interest rate *i* received by savers, while the loan demand schedule *LD* shows the demand for such funds for each possible value of the interest rate that must be paid by borrowers. Note that the slopes for the curves *LS* and *LD* both reflect the same principle, which is that a higher interest rate gives both savers and borrowers a reason to defer current spending to a greater extent. Equilibrium in the credit market then determines both a market-clearing interest rate and an equilibrium volume of lending, as shown by i_1 and L_1 in the figure.

In Figure 2A, the loan supply and demand curves are specified while holding constant a great many variables other than the current interest rate. In particular, the curves are shown assuming a particular level of current-period aggregate output (and hence income) *Y*. A higher level of income should increase the supply of loans at any given interest rate (as not all of the additional income should be consumed if future income expectations are held fixed); hence an increase in *Y* should shift
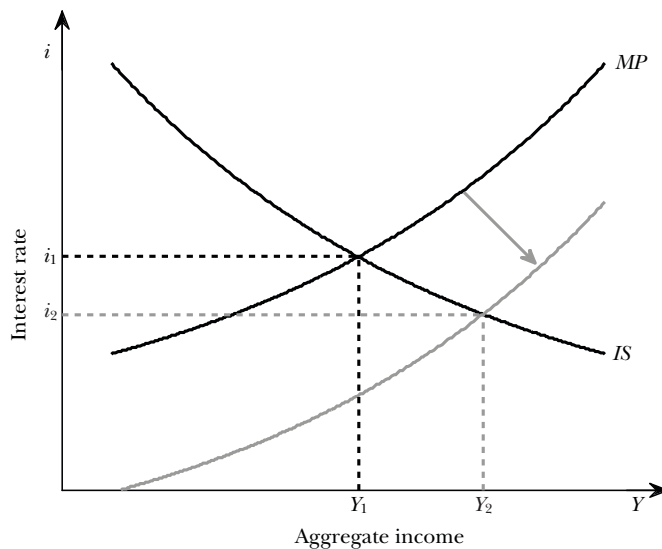
Interest-Rate and Output Determination in the Standard Model

A: Effect of an Increase in Aggregate Income on Loan Supply and Demand
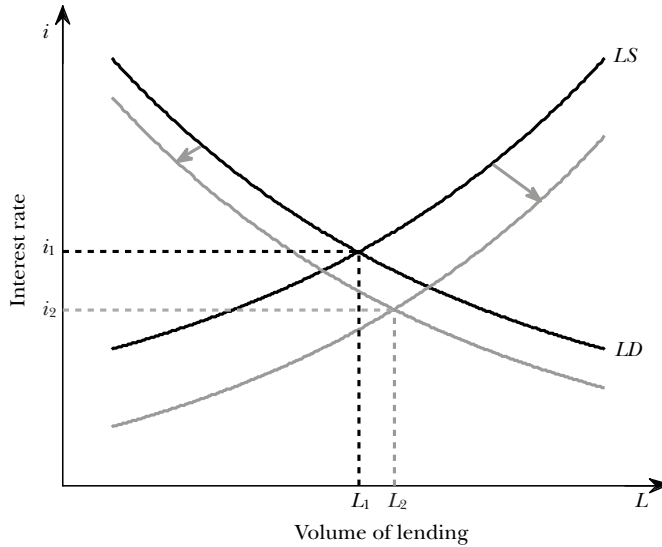
B: Effect of a Loosening of Monetary Policy on Interest Rates and Output

Notes: In panel A, *LS* is the loan supply schedule and *LD* is the loan demand schedule, which are specified holding constant aggregate income, *Y*. The arrows show how the curves shift with an increase in *Y*. Panel B shows an *IS* schedule, derived by tracing out the equilibrium interest rate for any assumed level of current income *Y*, and a monetary policy reaction function (*MP*), showing how the central bank's interest rate target will vary with the level of economic activity. The *MP* curve is drawn for a given inflation rate. The arrow shows the consequence of an exogenous shift in the policy reaction function that implies a lower interest rate for any given level of economic activity.

the *LS* curve down and to the right, as shown by the arrow. It should also reduce the demand for loans, insofar as borrowers have more current income available out of which to finance current spending needs or opportunities, in which case the *LD* curve shifts down and to the left, as also shown in the figure. The vertical shift in the *LD* curve is likely to be smaller than the vertical shift of the *LS* curve, as shown in Figure 2A, if the expenditure of borrowers is more interest-elastic than the expenditure of savers. The intersection of the grey curves shows the new equilibrium values, i_2 and L_2.

Tracing out the equilibrium interest rate for any assumed level of current income *Y*, one obtains the *IS* schedule plotted in Figure 2B. (Alternatively, for each possible interest rate *i*, the schedule shows the level of national income for which investment equals savings, as this is equivalent to equality between supply of and demand for funds.) The monetary policy reaction function of the central bank, indicating how the central bank's interest-rate target will vary with the level of economic activity, is shown by the curve *MP* in this figure.[3]

If we suppose that the *MP* curve is drawn for a given inflation rate, then the upward slope shown indicates a response of interest rates to the level of output (relative to trend or to potential), of a kind implied, for example, by the "Taylor rule" (Taylor, 1993)—that is, higher interest rates when output is high relative to trend or potential, and lower interest rates when output is low relative to trend or potential. In this case, the equilibrium level of output determined in Figure 2B depends on the inflation rate; a graph showing how the equilibrium level of output would vary with inflation yields an aggregate demand relation in inflation–output space. Plotting that relation along with a Phillips curve (or aggregate supply) relation between inflation and output, one can then finally determine equilibrium output.[4]

This kind of model provides a straightforward account of the way in which a central bank's interest-rate policy affects the level of economic activity (and also the inflation rate, once one adjoins a Phillips curve to the model). However, this model of the credit market—in which ultimate savers lend directly to ultimate borrowers so that the interest rate received by savers is the same as that paid by borrowers—clearly omits some important features of actual financial systems. In actual economies, we observe multiple interest rates that do not move perfectly together. Changes in spreads between certain of these interest rates have been important indicators of changing financial conditions, both during the recent housing boom and during the subsequent crash, as is discussed further below.

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[3] In the case that monetary policy is assumed to correspond to some fixed supply of money, then the *MP* curve becomes simply the Hicksian *LM* curve. However, an upward-sloping relation of the kind shown in the figure will exist under many other hypotheses, including ones more descriptive of actual central bank behavior than the Hicksian construct. On the relation between *IS–MP* analysis and the older *IS–LM* analysis, see, for example, Romer (2000) in this journal.

[4] Alternatively, one can substitute the inflation rate implied by the Phillips curve (for a given level of output) into the central bank reaction function, and plot the resulting relation for *i* as a function of *Y* as the curve *MP*. In this case, *MP* slopes upward, as shown, even if the central bank's reaction function responds only to inflation; and the equilibrium shown in Figure 2B already takes account of the endogeneity of the inflation rate.

Introducing Multiple Interest Rates

Here I illustrate one way to introduce multiple interest rates into this model. Suppose that instead of directly lending to ultimate borrowers themselves, savers fund intermediaries, who use these funds to lend to (or acquire financial claims on) the ultimate borrowers. Then, it becomes necessary to distinguish between the interest rate i^s (the rate paid to savers) at which intermediaries are able to fund themselves and the interest rate i^b (the borrowing or loan rate) at which ultimate borrowers are able to finance additional current expenditure. We can still think in terms of the two schedules shown in Figure 2A, but now the *LS* schedule represents the supply of funding for intermediaries rather than the supply of loans to ultimate borrowers, and we must now recognize that the supply of funding and the demand for loans are functions of two different interest rates. Hence the equilibrium level of lending L can be at a point other than the one where the two schedules cross, as shown in Figure 3A.

What determines the equilibrium relation between the two interest rates i^s and i^b? Given the funding supply and loan demand curves (which means, given the values of a set of variables that include the current value of income Y), we can determine the unique volume of intermediation that is consistent with any given spread ω between i^b and i^s. If the funding supply curve *LS* and the loan demand curve *LD* have the slopes shown, then a larger credit spread ω implies a lower equilibrium volume of intermediated credit L. This relation between the quantity of intermediated credit and the credit spread is graphed as the curve *XD* in Figure 3B, which we can think of as the "demand for intermediation."

The demand for intermediation schedule *XD* indicates the degree to which borrowers are willing to pay an interest rate higher than the one required in order to induce savers to supply funds to finance someone else's expenditure. This represents a profit opportunity for intermediaries, to the extent that they are able to arrange for the transfer of funds at sufficiently low cost. The volume of lending that actually occurs, though, will also depend on the capacity of the financial sector to supply this service at a margin low enough for the services to be demanded.

The corresponding "supply of intermediation" schedule, indicating the credit spread required to induce financial institutions to intermediate a certain volume of credit between savers and ultimate borrowers, is depicted by the curve *XS* in Figure 3B. This curve reflects the consequences of profit maximization by intermediaries, where the intermediaries in question need not be understood to consist solely or even primarily of traditional commercial banks. Both the equilibrium credit spread and the equilibrium volume of credit are then determined by the intersection between the *XS* and *XD* schedules. And given an equilibrium credit spread ω, determined in Figure 3A, one can use Figure 3A to determine the two interest rates.

Determinants of the Supply of Intermediation

The structural relationship represented by the supply of intermediation schedule *XS* in Figure 3B can be motivated in various ways. One model assumes that intermediaries have costs of originating and servicing loans, or of managing
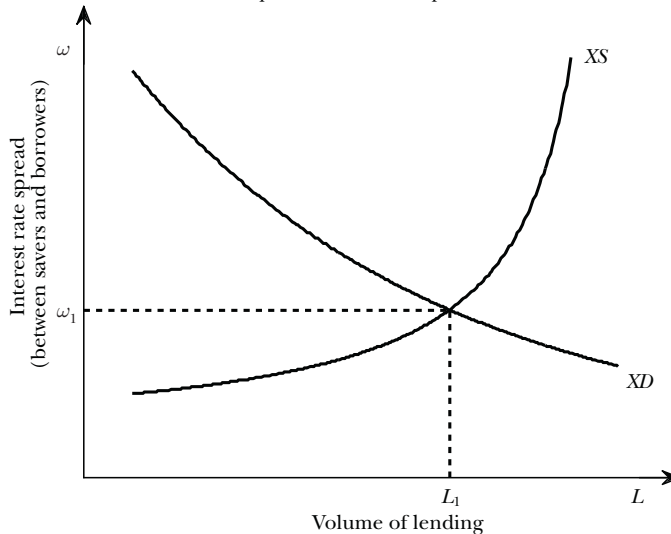
Figure 3
Credit Market Equilibrium with Credit Supply Frictions

A: Effect of a Credit Spread ω_1 on the Equilibrium Interest Rates for
Borrowers and Savers, and on the Equilibrium Volume of Credit
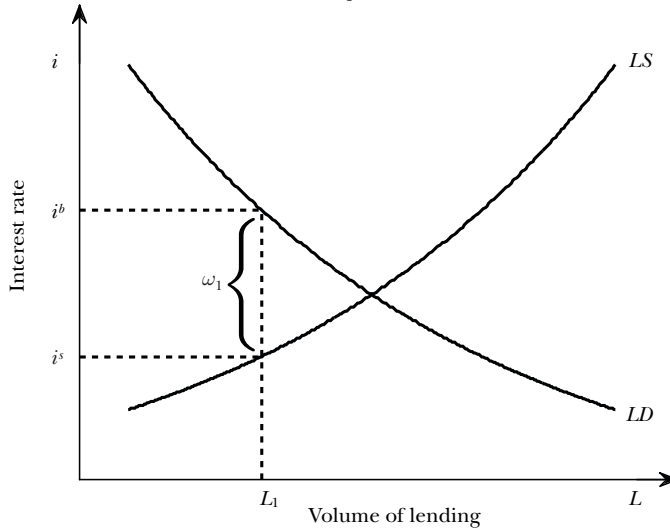
B: Determination of the Equilibrium Credit Spread

Notes: i^s is the interest rate paid to savers, at which intermediaries are able to fund themselves, and i^b is the interest rate (the borrowing or loan rate) at which ultimate borrowers are able to finance additional current expenditure. In this figure, *LS* schedule represents the supply of funding for intermediaries, the *LD* schedule is the loan demand schedule, and these schedules are functions of two different interest rates. Hence the equilibrium level of lending L can be at a point other than the one where the two schedules cross, as shown in Figure 3(a). ω is the spread between i^b and i^s. Given the *LS* and *LD* curves we can determine the unique volume of intermediation that is consistent with any given spread ω. This relation between the quantity of intermediated credit and the credit spread is graphed as the curve *XD* in panel B, which we can think of as the "demand for intermediation." The corresponding "supply of intermediation" schedule *XS* indicates the credit spread required to induce financial institutions to intermediate a certain volume of credit between savers and ultimate borrowers.

their portfolios, so that in a competitive equilibrium, the rate i^b at which they are willing to lend (or the return that they will require on assets that they purchase) will exceed their cost of funds i^s by a spread that reflects the marginal cost of lending. This marginal cost may be increasing in the volume of lending by the intermediary if the production function for loans involves diminishing returns to increases in the variable factors, owing to the fixity of some factors (such as specialized expertise or facilities that cannot be expanded quickly).[5]

Probably a more important determinant of the supply of intermediation derives from the limited capital of intermediaries—or, more fundamentally, the limited capital of the "natural buyers" of the debt of the ultimate borrowers—together with limits on the degree to which these natural buyers are able to leverage their positions. The market for the debt of the ultimate borrowers may be limited to a narrow class of "natural buyers" for any of a variety of reasons: special expertise may be required to evaluate such assets; other costs of market participation may be lower for certain investors; or the natural buyers may be less risk averse, or less uncertainty averse, or more optimistic about returns on the particular assets.

Leverage may also be constrained for any of a variety of reasons. The recent literature has emphasized two broad types of constraints. On one hand, there may be a limit on the size of the losses that the intermediary would be subject to in bad states of the world, relative to its capital; such limits may result from regulatory capital requirements, or (the case of greatest relevance in the recent crisis) such limits may be imposed by the intermediary's creditors, who are unwilling to supply additional funding if the leverage constraint is exceeded (as in Zigrand, Shin, and Danielsson, 2010; Adrian, Moench, and Shin, 2010b; Adrian and Shin, forthcoming b; Beaudry and Lahiri, 2010).[6]

Alternatively, intermediaries may raise funds by pledging particular assets as collateral for individual loans, and the amount that they can borrow may be limited by the value of available collateral. Gârleanu and Pedersen (2010) and Ashcraft, Gârleanu, and Pedersen (forthcoming) consider the consequences of collateral constraints in a model where the fraction of each asset's value that can be borrowed using that asset as collateral is among the defining characteristics of the asset. Geanakoplos (1997, 2003, 2010) instead proposes a theory in which margin requirements are endogenously determined in competitive markets.

Under these types of theories, the capital of intermediaries becomes a crucial determinant of the supply of intermediation. For a given quantity of capital, the

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[5] This is one of two relatively reduced-form models of endogenous credit spreads considered in the monetary dynamic stochastic general equilibrium model we present in Cúrdia and Woodford (2009). The device of a "loan production function" is also used in Goodfriend and McCallum (2007) and in Gerali, Neri, Sessa, and Signoretti (2010).

[6] The "value-at-risk constraint" assumed by authors such as Zigrand, Shin, and Danielsson (2010), Adrian, Moench, and Shin (2010b), and Adrian and Shin (forthcoming b) is an example of a constraint of this form. Beaudry and Lahiri (2010) impose a similar constraint by simply assuming that intermediaries can sell only riskless debt. The constraint assumed by Adrian and Shin (forthcoming b) is formally equivalent to the one assumed by Beaudry and Lahiri (2010), though the former authors prefer to interpret the constraint as one on value at risk.

supply schedule *XS* will be upward sloping, as shown in Figure 3B, if the acceptable leverage ratio is higher when the spread between the expected return on the assets in which intermediaries can invest and the rate they must pay on their liabilities is greater. Consider, for example, a value-at-risk constraint, that requires the future value of the intermediary's assets to be worth at least some fraction *k* of the amount owed on its debt, with at least some probability $1 - p$; and suppose that the risky asset in which the intermediary invests will pay at least a fraction *s* of its expected payoff with probability $1 - p$. Then the value-at-risk constraint is satisfied if and only if the intermediary's leverage ratio (debt as a fraction of the total value of its assets) is no greater than *s/k* times the factor $(1 + i^b)/(1 + i^s)$, where i^b is the expected return on the risky asset and i^s is the rate that the intermediary must pay on its debt. Thus the acceptable leverage ratio, and correspondingly the maximum value of assets that the intermediary can acquire, will be an increasing function of the credit spread.

The *IS–MP* Model with Credit Frictions

The equilibrium credit spread and volume of credit shown in Figure 3A are determined for a particular value of national income *Y*; because the schedules *LS* and *LD* depend on *Y*, as shown in Figure 2A, the location of the schedule *XD* (at least) in Figure 3B also depends on *Y*. For reasons already discussed above, a higher level of *Y* should shift *LS* to the right and *LD* to the left, and each of these effects results in a lower equilibrium value of the rate i^s paid to savers, for any given position of the schedule *XS*. Hence we can once again derive an *IS* schedule, indicating the equilibrium value of i^s for any assumed level of income *Y*, but now the *IS* schedule will also include a given assumption about the supply of intermediation.[7]

The resulting model makes many of the same qualitative predictions about the effects of economic disturbances or policy changes as the standard *IS–MP* model (which is simply the special case in which the curve *XS* is assumed to be horizontal at $\omega = 0$). However, the dependence of the supply of intermediation on the capital of intermediaries provides a channel for the amplification and propagation of the effects of economic disturbances. An increase in aggregate economic activity will generally increase the value of intermediaries' assets (loans are more likely to be repaid, land prices increase with increases in income, and so on) and hence their net worth. This will allow additional borrowing by the intermediaries, and hence a larger volume of credit for any given credit spread. Thus, the supply of intermediation schedule *XS* will shift down and to the right. A reduction in the interest rate

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[7] In fact, we can now solve for both i^s and i^b as functions of *Y*, but it is the relation between i^s and *Y* that is relevant for the *IS–MP* diagram, since it is i^s—the rate at which intermediaries are able to fund themselves—that corresponds to the operating target of the central bank. Plotting again the reaction of the central bank's target for i^s to changes in economic activity as a curve *MP*, we again have a diagram of exactly the kind shown in Figure 2B to determine simultaneously the equilibrium values of the interest rate and output; the only important difference is that now we must clarify that the interest rate on the vertical axis is the policy rate i^s rather than the borrowing rate i^b. Once the equilibrium values of *Y* and i^s have been determined, they can be transferred back to Figures 3A and B to determine the implied equilibrium values of i^b and *L* as well.

i^s at which intermediaries are able to fund themselves can also increase intermediaries' net worth, if (as is often the case) they fund longer-term assets with short-term borrowing that they must roll over, and in this case a reduction in i^s will shift the *XS* curve down and to the right as well.

Each of these effects will make the *IS* curve flatter (more interest-elastic) than it would otherwise be.[8] This means that a shift in the *MP* curve—due either to a change in monetary policy or to a supply-side disturbance that shifts the aggregate-supply curve—will have a larger effect on output as a consequence of these "financial accelerator" effects. Bernanke and Gertler (1995) discuss evidence for the importance of such effects in the case of monetary policy shocks. Moreover, if a disturbance leads to an increase or decrease in the capital of the intermediary sector, the altered level of capital is likely to persist for some time. This can result in effects on economic activity that are more persistent than the initial disturbance.

The presence of an upward-sloping *XS* curve (representing credit frictions) essentially makes the *IS* curve steeper, and consequently acts to dampen the effects on aggregate output of disturbances that shift the *MP* curve, to the extent that the *XS* schedule is not itself shifted by the disturbances. In fact, however, the *XS* schedule may well shift, in which case the net effect may well be to amplify output fluctuations, rather than to dampen them.

Consequences of Shifts in the Supply of Intermediation

A more important consequence of this extension of the model is the fact that shifts in the *XS* schedule—for either exogenous or endogenous reasons—become an additional source of variations in aggregate demand, and hence in economic activity and inflation.[9] A disruption of the supply of intermediation will shift the *XS* schedule up, so that financial intermediaries supply less credit at every level of the credit spread ω. As shown in Figure 4A an upward shift in *XS* results in a higher equilibrium credit spread, and a lower volume of lending, for any given level of economic activity (reflected in the location of the *XD* schedule in the figure). Transferring this larger spread back to Figure 3A, one observes that the implied value of i^s will be smaller, and the implied value of i^b higher, for the given value of *Y*. Because this is true for each possible value of *Y*, the *IS* schedule is shifted down and to the left, as shown in Figure 4B. (Note that *IS* plots the equilibrium value of i^s rather than that of i^b, because the policy reaction function specifies a target for i^s rather than for i^b.) In the absence of any change in the monetary policy reaction

[8] Of course, these reasons for the *IS* curve to be flatter must be balanced against the observation that a steeper *XS* curve for a given level of capital in the intermediary sector will imply a steeper *IS* curve. This is why the degree of amplification from credit frictions that is found in quantitative dynamic stochastic general equilibrium models is sometimes quite modest.
[9] The empirical dynamic stochastic general equilibrium models of Christiano, Motto, and Rostagno (2010) and Gilchrist, Ortiz, and Zakrajsek (2009) each attribute a substantial fraction of the short-run variability of real GDP to disturbances that vary the severity of financial frictions.
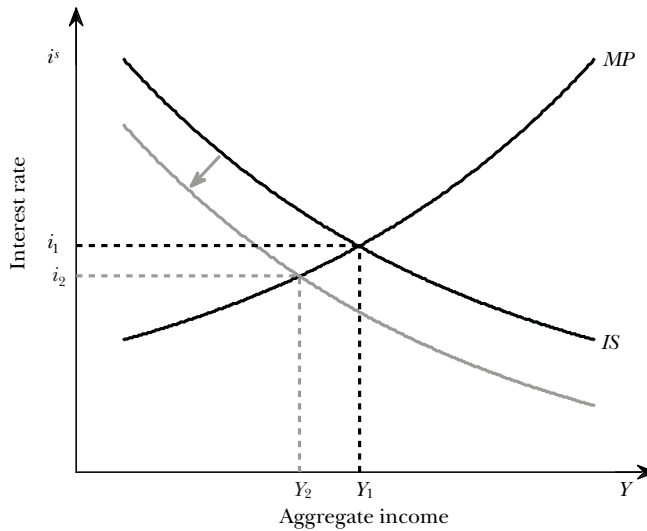
Figure 4
Effects of a Disruption of Credit Supply

A: Effects on the Equilibrium Credit Spread ω and Volume of Lending L
for a Given Level of Aggregate Income Y
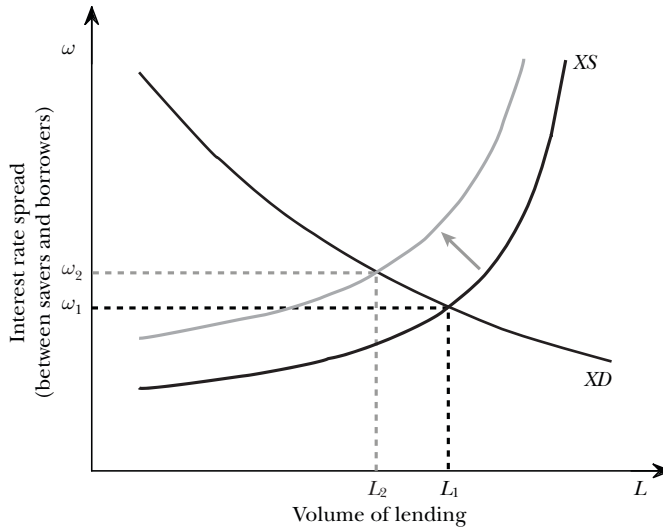
B: Effects on the Equilibrium Policy Rate and Aggregate Income,
Taking into Account the Monetary Policy Reaction

Notes: *XS* and *XD* are the supply and demand for intermediation. ω is the spread between i^b, the interest rate for borrowers, and i^s, the interest rate for savers. The *IS* schedule shows the equilibrium interest rate for any assumed level of current income Y, and *MP* is the monetary policy reaction function (*MP*).

function, the upward shift in *XS* should result in both a decline in the policy interest rate and a contraction of real activity.[10]

This prediction matches the consequences observed, for example, when the Carter administration imposed credit controls in the second quarter of 1980. This policy was followed by a contraction in real GDP at a rate of minus 8 percent per year in that quarter, while the federal funds rate also fell from a level over 17 percent per annum in April to only 9 percent by July 1980. The effects of a policy tightening of this kind cannot be understood as a shift of the *MP* curve (or *LM* curve) in a conventional *IS–MP* (or *IS–LM*) diagram, but they are easily understood when one realizes how changes in the supply of intermediation schedule should be expected to shift the *IS* curve.

The dependence of the supply of intermediation on the capital of intermediaries also introduces an important channel through which additional types of disturbances can affect aggregate activity. Any disturbance that impairs the capital of the banking sector will shift the schedule *XS* up and to the left, with the effects just discussed. This means that shocks that might seem of only modest significance for the aggregate economy—in terms, say, of the total value of business losses that directly result from the shock—can have substantial aggregate effects if the losses in question happen to be concentrated in highly leveraged intermediaries, who suffer significant reductions in their capital as a result. This was an important reason for the dramatic aggregate effects in 2008–2009 of the losses in the U.S. subprime mortgage market.

The supply of intermediation can also shift as a result of factors other than a change in the capital of intermediaries; in particular, leverage constraints can tighten or loosen, as a result of changes in the attitudes of intermediaries' creditors regarding the acceptable degree of leverage, or in the margin requirements associated with borrowing against the securities that intermediaries hold. Gorton and Metrick (2009), Adrian and Shin (2009), and Geanakoplos (2010) have all stressed the importance of increases in margin requirements in the overnight repurchase (or "repo") market as a factor that contracted the supply of credit in 2008 and 2009.

Even when shocks to the supply of intermediation originate in a tightening of leverage constraints and/or margin constraints owing to an increased assessment of the risk associated with intermediaries' assets, the effects of the shocks will be amplified by the dependence of the supply of intermediation on the capital of the intermediary sector. Intermediaries that are forced to sell assets as a result of tightened leverage constraints are likely to suffer losses, and more so to the extent that many of them are forced to sell similar assets at the same time, or to the extent that they are the only "natural buyers" of the assets in question. These losses will then further reduce their capital, further reducing the amount that they are able

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[10] In this respect the framework sketched here agrees with the one proposed by Bernanke and Blinder (1988), who refer to the relation that I call the *IS* curve as the "commodities and credit curve" instead, precisely because it is shifted by credit-supply shocks in addition to the usual determinants of the *IS* curve. The framework proposed here differs from that of Bernanke and Blinder primarily in offering a different model of the supply of intermediation.

to borrow, and hence requiring further asset sales. The result is a vicious spiral that under some circumstances can substantially reduce credit supply. The resulting contraction of aggregate output may result in further losses to the banks, further reducing their capital, and hence tightening credit supply even more.

The Most Recent U.S. Credit Cycle

Understanding variations in financial conditions over the most recent credit cycle requires attention to the behavior of multiple interest rates, not just the federal funds rate that is targeted by the Federal Reserve. As shown in Figure 5, the Fed Open Market Committee raised its target for the funds rate to a higher level during the period 2006–07; but financial conditions did not tighten as much as one might expect from the increase in the funds rate. First of all, spending decisions depend more on the level of *long-term* interest rates, which in turn depend on the expected average level of short rates over the coming decade, rather than the current level of short rates alone. Since there was good reason to regard the low level of the federal funds rate in 2003–04 as a temporary anomaly,[11] the long rate implied by the expected average future level of the short rates did not greatly increase as a result of the increase in the funds rate between 2004 and 2006.

Moreover, yields on long-term Treasury bonds did not rise by even this much. The term premium, which indicates the amount by which the actual yield on a long-term bond exceeds the expected average level of short-term interest rates over the term to maturity of the bond, declined during this period, as Figure 5 illustrates for the case of a 10-year bond. In turn, the rates at which private parties can borrow are not those applicable to the U.S. Treasury; the figure also shows, for example, that the spread between the average yield on Baa-rated corporate bonds and 10-year Treasuries also fell between 2004 and 2006.[12] Hence corporate borrowing costs actually fell, despite the increase in the federal funds rate, owing to the declines in the two spreads! In contrast, the increases in the two spreads during the financial crisis greatly increased the cost of borrowing.

Even in the case of short-term borrowing, the federal funds rate alone is not always an adequate measure of money market conditions. Figure 5 also plots the spread between the three-month U.S. dollar London Interbank Offer Rate

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[11] For example, see the "fitted" long rates implied by the forecasting model of Kim and Wright (2005). Indeed, the series plotted in Figure 5 is taken from the estimates of Kim and Wright (2005); their series is updated at ⟨http://www.federalreserve.gov/econresdata/researchdata.htm⟩.

[12] The spread between yields on this class of moderately risky corporate bonds and on similar-maturity Treasury bonds is a commonly watched indicator of disturbances to the market for corporate debt, which is strongly correlated with variations in economic activity. Gilchrist, Ortiz, and Zakrajsek (2009) use an index of corporate bond spreads as a measure of the time-varying financial wedge in an estimated monetary dynamic stochastic general equilibrium model and find that the co-movements of the bond spreads with other aggregate variables are consistent with this interpretation.

Figure 5
The Federal Funds Rate Target and Some Interest-rate Spreads
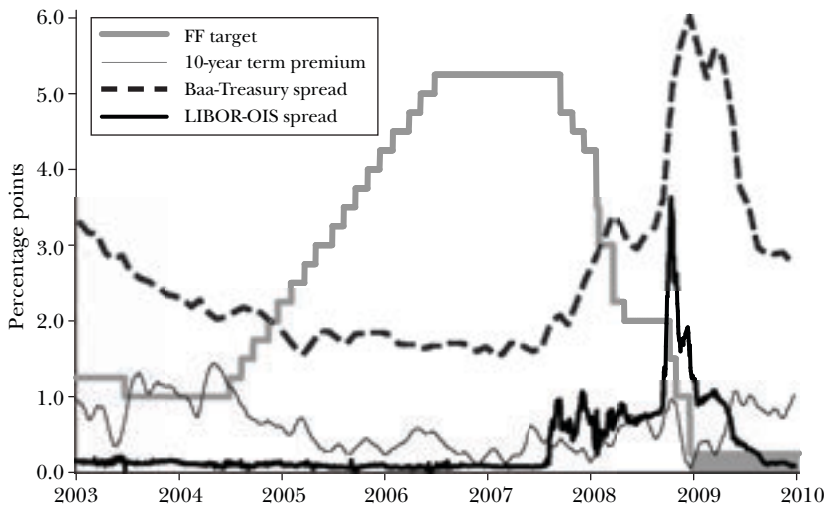
Sources: The FF target is from the Federal Reserve Board; the 10-year term premium was calculated by Don H. Kim and Jonathan H. Wright (available at the Federal Reserve Board website); the Baa–Treasury spread is from the Federal Reserve Bank of St. Louis; the LIBOR-OIS spread is from Bloomberg.
Notes: The "FF target" is the Federal Funds rate target. The "10-year term premium" is the amount by which the yield on a 10-year bond exceeds the expected average level of short-term interest rates over the term to maturity of the bond. The "Baa–Treasury spread" is the spread between Baa-rated corporate bonds and 10-year Treasuries. The "LIBOR–OIS spread" is the spread between the three-month U.S. dollar London Interbank Offer Rate (LIBOR) and the overnight interest-rate rate swap (OIS) rate.

(LIBOR)[13] and the overnight interest-rate rate swap (OIS) rate, which can be viewed as essentially a market forecast of the average level of the federal funds rate over that three-month period. The sharp increases in this spread during the crisis indicate that the short-term borrowing costs of many banks (especially late in 2008) were considerably higher than would be indicated by the federal funds rate.

It is popular to attribute the credit boom (at least in part) to the Federal Reserve having kept the federal funds rate "too low for too long," but comparison of the path of the funds rate in Figure 5 with the measures of credit growth in Figure 1A shows that the increase in lending was greatest in 2006 and the first half of 2007, after the federal funds rate had already returned to a level consistent with normal benchmarks. Instead, the fact that spreads were unusually low precisely during the period of strongest growth in lending—as can be seen by comparing the spreads

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[13] The LIBOR rate is an average of quoted rates at which banks are able to borrow funds for a short term (3 months, in the case of the series plotted here) on an uncollateralized basis. It is important not only because it is the cost of additional funds for some banks, but because other lending rates—such as the interest rate at which commercial and industrial loans are available to firms under existing loan commitments—are often tied to the LIBOR rate. For alternative interpretations of variations in the LIBOR–OIS spread, see Giavazzi (2008), Sarkar (2009), and Taylor and Williams (2009).

shown in Figure 5 with the quantities in Figure 1—indicates that an outward shift of the supply of intermediation schedule *XS* was responsible, rather than a movement along this schedule in response to a loosening of monetary policy. The reason for the shift seems to have been an increased appetite of investors for purportedly low-risk short-term liabilities of very highly leveraged financial intermediaries; in this journal, Brunnermeier (2009) details the changes in financing patterns during this period.

The effects of such a shift were like those shown in Figure 4, but with the reverse sign; as a consequence, the Fed's increase in the funds rate over the period between 2004 and 2006 did less to restrain demand than would ordinarily have been expected.[14] The increase in the riskless short-term rate did reduce households' and firms' willingness to hold demand deposits, as a conventional money-demand equation would imply, and checkable deposits declined during this period, as shown in Figure 1B; but this did not prevent a net increase in the overall liabilities of financial intermediaries, and hence in credit supply.

The financial crisis that began in summer 2007 also originated in a change in the supply of intermediation. It began when increased perceptions of risk resulted in increases in the margin requirements demanded by creditors in short-term lending collateralized by mortgage-backed securities, creating a liquidity crisis for issuers of asset-backed commercial paper. The effect of deleveraging in this sector on the market value of mortgage-backed securities further impaired the capital of financial intermediaries more broadly, requiring further deleveraging, in a vicious spiral: again, Brunnermeier (2009) describes this process in detail in this journal.

In terms of the model, the net result of both reductions in the acceptable degree of leverage and impairment of the capital of the financial sector was a sharp leftward shift of the supply of intermediation *XS*. As illustrated by Figure 4, the result was a simultaneous contraction of the volume of lending, as shown in Figure 1, and an increase in spreads, as shown in Figure 5. The resulting leftward shift of the *IS* curve (Figure 4) meant a contraction of aggregate demand, despite the substantial cuts in the federal funds rate shown in Figure 5. The reduction in the riskless short-term rate caused an increased willingness to hold transactions deposits, and checkable deposits increased substantially, as seen in Figure 1B. But plentiful deposits were not enough to restore the flow of credit, for an inability to increase the volume of deposits was not the relevant constraint on the supply of credit.

Once this process was underway—and given that, for a time, it appeared that the crisis might spiral out of control—uncertainty about the macroeconomic environment likely caused a further leftward shift of the *IS* curve, by increasing precautionary saving and increasing the option value of deferring investment. Once the *IS* curve shifted sufficiently far, it ceased to be possible to maintain

[14] Under this analysis, the fact that the Fed did not tighten policy even further can be said to have contributed to the credit boom. But the problem was not that the Fed failed to conform to the conventional benchmark provided by the "Taylor rule," as argued by Taylor (2009), but rather that it followed it too faithfully, rather than taking account of the change in financial conditions.

output near potential through cuts in the federal funds rate alone, owing to the zero lower bound on nominal interest rates. Of course, the fact that reduced aggregate demand resulted in lower economic activity and employment, rather than simply in reductions in wages and prices to the extent needed to maintain full employment, depended on the stickiness of wages and prices, as described in standard textbook accounts.

Implications for Monetary Policy

To what extent does this extension of the standard model imply changes to the conventional conduct of monetary policy?

Taking Account of Financial Conditions

The model's most obvious implication is that decisions about interest-rate policy should take account of changes in financial conditions—in particular, of changes in *interest-rate spreads.* Suppose that one's goal is to set a value of the policy rate at each point in time that is consistent with output equal to potential (or, more precisely, the "natural rate of output" in the sense of Friedman, 1968). In the model sketched above, this interest rate can be determined at any time given two other numbers: 1) the current value of the "natural rate of interest"—the real interest rate required for output equal to the natural rate, in the absence of financial frictions[15]—converted into an equivalent nominal interest rate by adding the current expected inflation rate, and 2) the current interest-rate spread ω.[16]

The model therefore suggests that changes in credit spreads should be an important indicator in setting the federal funds rate; the funds rate target should be lower than would otherwise be chosen, given other conditions, when credit spreads are larger. John Taylor (2008) has proposed, in this spirit, that his well-known rule for setting the federal funds rate target (explained in Taylor, 1993) should be modified to specify a funds rate target equal to that prescribed by the standard "Taylor rule" minus the current value of the LIBOR–OIS spread shown in Figure 5. In Cúrdia and Woodford (2010a), my coauthor and I show, in the context of a New Keynesian dynamic stochastic general equilibrium model with credit frictions, that such a modification of the standard Taylor rule can improve the economy's response to disturbances to the supply of intermediation.

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[15] This concept, derived from the ideas of Knut Wicksell, is discussed extensively in Woodford (2003, chap. 4). One might alternatively define the natural rate as the real rate that would be required for output equal to the natural rate of output under the assumption of a credit spread equal to some normal (steady state) level; the important feature of the proposed definition is that it abstracts from the effects of variations in the size of credit frictions.

[16] In Cúrdia and Woodford (2009), we derive an intertemporal version of the "*IS* curve" in which the credit spread appears as a shift factor. Gaspar and Kashyap (2006) were perhaps the first to propose such a relation.

Alternatively, a forecast-targeting approach to monetary policy of the kind I recommended in this journal in Woodford (2007)—in which the central bank's target for the policy rate should be adjusted as necessary in order for its projections of inflation and real activity to satisfy a quantitative target criterion—will automatically incorporate responses to changes in financial conditions to the extent that these shift the *IS* curve, as in the model sketched above. In addition, this alternative approach has the advantage of not requiring the central bank to focus on a single interest rate spread when multiple aspects of financial conditions are each relevant to aggregate demand and supply determination.

"Unconventional" Monetary Policies

The model also implies that traditional interest-rate policy alone will not, in general, provide a fully adequate response to a disturbance to credit supply, no matter how large the cut in the policy rate that may be engineered. The reason is that even if a sufficient reduction in the policy rate can offset the decline in aggregate demand that would otherwise result from the shift in the *IS* curve, this does not fully undo the distortions created by the increase in credit spreads. To the extent that savers would be willing to supply additional funds at an interest rate lower than the rate at which borrowers would be willing to borrow additional funds, then there remains a misallocation of expenditure, even if the aggregate level of expenditure is optimal: on this point, in Cúrdia and Woodford (2009), my coauthor and I provide an explicit welfare analysis. Thus, to the extent that it is possible for policy to reduce the size of the credit spread, this is desirable, even when interest-rate policy is able to maintain output at potential.

But the case for acting to reduce credit spreads becomes even stronger if the policy rate is constrained by the zero lower bound on nominal interest rates. In the case of a large enough disturbance to the supply of intermediation, the *IS* curve may shift so far down to the left that the point on it corresponding to the natural rate of output may involve a negative nominal interest rate; for quantitative examples, see Cúrdia and Woodford (2010b). In this case, conventional monetary policy is unable to achieve the required level of aggregate demand, because even a massive expansion of the supply of bank reserves cannot drive the policy rate below zero. (The Federal Reserve found itself in this situation after December 2008, as shown in Figure 5.) Under such circumstances, a policy that can reduce credit spreads can further increase aggregate demand (by shifting the *IS* curve to the right), despite the lack of room for any further reduction in the policy rate.

Broadly speaking, two types of "unconventional" central-bank policies can reduce credit spreads by shifting the supply of intermediation schedule *XS* to the right. One is the extension of credit to intermediaries by the central bank on easier terms than are available from private creditors; in particular, in the case that the relevant financing constraint is the existence of too-high margin requirements for private lending using assets held by the intermediaries as collateral, the central bank may choose to lend against that collateral with a lower margin requirement.

Ashcraft, Gârleanu, and Pedersen (forthcoming) discuss the Federal Reserve's Term Asset-Backed Lending Facility, which provided financing for private purchases of asset-backed securities, as an example of a policy of this kind and present evidence of its success at reducing the spreads associated with asset-backed securities eligible for the program. Such a policy can relax the constraint on the size of intermediary balance sheets resulting from limited capital in the intermediary sector, by allowing increased leverage.

Alternatively, the central bank may directly purchase debt claims issued by private borrowers, so that total credit extended to the private sector can exceed the size of intermediary balance sheets. Examples of policies of this kind during the recent crisis include the Fed's purchases of commercial paper through its Commercial Paper Funding Facility and its purchases of mortgage-backed securities and agency debt. On the motivation for and effects of these programs, see, for example, Adrian, Kimbrough, and Marchioni (2010), Gagnon, Raskin, Remache, and Sack (2010), and in this journal Kacperczyk and Schnabl (2010). In this case as well, the supply of intermediation *XS* is shifted to the right even though the equilibrium relation between the credit spread and the quantity of risky assets that can be held on the balance sheets of private intermediaries does not change.[17]

It should not be assumed that because it is possible in principle for the central bank to reduce equilibrium spreads through direct intervention in credit markets, it is therefore desirable for the central bank to intervene continually to maintain zero spreads. In Cúrdia and Woodford (2010b), we assume costs of central-bank lending to the private sector that imply that under normal circumstances, it will not be optimal for the central bank to hold assets other than highly liquid Treasury securities on its balance sheet; but even so, central-bank lending to the private sector can be justified on welfare grounds in the case of a large enough disruption of credit supply. Gertler and Karadi (2010) reach a similar conclusion using a related model.

Monetary Policy and Financial Stability

Finally, the fact that a reduction in the capital of intermediaries has an adverse effect on the supply of intermediation—which in turn can seriously disturb both aggregate demand and the composition of expenditure—implies that it is desirable to reduce how frequently such crises occur. The role that monetary policy can or should play in this regard remains controversial. However, a crisis that sharply reduces intermediary capital can more easily occur, in the sense that the size of the required exogenous disturbance is smaller, when intermediaries are highly leveraged. Thus, while the increased volume of lending that a relaxation of leverage constraints makes possible

[17] Note that on this analysis, the effects of targeted central bank asset purchases have nothing to do with "quantitative easing," as the effects do not depend on the purchases being financed by an increase in bank reserves, nor do conditions in the market for bank reserves play any role in our analysis. See Cúrdia and Woodford (2010b) for further discussion.

can improve the short-run allocation of resources, this benefit must be weighed against the increased risk of occurrence of a crisis that will (if it occurs) increase distortions in the future, in ways that monetary policy will not then be able to counteract fully.

The model sketched here implies that increased leverage in the financial sector is a natural consequence of looser monetary policy because of the effects of higher incomes on loan demand and supply, shown in Figure 2A. Other, more complex mechanisms, such as the model of misperception of risk by the funders of intermediaries proposed by Dubecq, Mojon, and Ragot (2009) can make this effect even stronger. Given this, the consequences of policy for financial stability need to be considered in making interest-rate decisions, alongside the consequences of policy for aggregate economic activity and inflation.

The nature of this consideration should not be completely symmetrical: marginal adjustments of interest rates always have consequences for output and inflation, while they will have nonnegligible consequences for the risk of financial instability only at certain times when the leverage is extreme enough for even small changes in asset values to have substantial effects on intermediary capital. Improved regulation and/or macroprudential supervision could further reduce the range of circumstances in which this consideration would matter for monetary policy decisions; and this would be desirable, if possible, as freeing monetary policy to focus solely on output and inflation stabilization should allow those goals to be more effectively achieved. But in the absence of a complete solution of that kind, it is difficult to defend the view that financial stability can be ignored in monetary policy decisions; and the development of practical real-time indicators of risks to financial stability is accordingly an important challenge of the present moment.

References

Adrian, Tobias, Karin Kimbrough, and Dina Marchioni. 2010. "The Federal Reserve's Commercial Paper Funding Facility." Federal Reserve Bank of New York Staff Report 423.

Adrian, Tobias, Emanuel Moench, and Hyun Song Shin. 2010a. "Financial Intermediation, Asset Prices and Macroeconomic Dynamics." Federal Reserve Bank of New York Staff Report 422.

Adrian, Tobias, Emanuel Moench, and Hyun Song Shin. 2010b. "Macro Risk Premium and Intermediary Balance Sheet Quantities." Federal Reserve Bank of New York Staff Report 428.

Adrian, Tobias, and Hyun Song Shin. 2009. "Prices and Quantities in the Monetary Policy Transmission Mechanism." *International Journal of Central Banking,* 5(4): 131–42.

Adrian, Tobias, and Hyun Song Shin. Forthcoming (a). "The Changing Nature of Financial Intermediation and the Financial Crisis of 2007–09." *Annual Review of Economics.*

Adrian, Tobias, and Hyun Song Shin. Forthcoming (b). "Financial Intermediaries and Monetary Economics." In *Handbook of Monetary Economics,* vol. 3, ed. B. M. Friedman and M. Woodford. Amsterdam: Elsevier.

Ashcraft, Adam, Nicolae Gârleanu, and Lasse Heje Pedersen. Forthcoming. "Two Monetary Tools: Interest Rates and Haircuts." In *NBER Macroeconomics Annual 2010,* ed. D. Acemoglu and M. Woodford. Chicago: University of Chicago Press.

Baker, Dean. 2010. "Blame It on the Bubble." *The Guardian,* March 8.

Beaudry, Paul, and Amartya Lahiri. 2010. "Risk Allocation, Debt Fueled Expansion, and Financial Crisis." June. http://faculty.arts.ubc.ca/alahiri /BeaudryLahiri.pdf.

Bennett, Paul, and Stavros Peristiani. 2002. "Are U.S. Reserve Requirements Still Binding?" Federal Reserve Bank of New York *Economic Policy Review,* 8(1): 53–68.

Bernanke, Ben S., and Alan S. Blinder. 1988. "Credit, Money, and Aggregate Demand." *American Economic Review,* 78(2): 435–39.

Bernanke, Ben S., and Mark Gertler. 1995. "Inside the Black Box: The Credit Channel of Monetary Policy Transmission." *Journal of Economic Perspectives,* 9(4): 27–48.

Bernanke, Ben S., Mark Gertler, and Simon Gilchrist. 1999. "The Financial Accelerator in a Quantitative Business Cycle Framework." Chap. 21 in *Handbook of Macroeconomics,* vol. 1C, ed. J. B. Taylor and M. Woodford. Amsterdam: Elsevier.

Brunnermeier, Markus. 2009. "Deciphering the Liquidity and Credit Crunch 2007–2008." *Journal of Economic Perspectives,* 23(1): 77–100.

Buiter, Willem H. 2010. "Housing Wealth Isn't Wealth." *Economics: The Open-Access, Open Assessment E-Journal,* vol. 4, no. 2010-22. http://www .economics-ejournal.org/economics/journal articles/2010-22.

Christiano, Lawrence, Roberto Motto, and Massimo Rostagno. 2010. *Financial Factors in Economic Fluctuations.* European Central Bank Working Paper 1192. http://www.ecb.europa.eu /pub/pdf/scpwps/ecbwp1192.pdf.

Cúrdia, Vasco, and Michael Woodford. 2009. "Credit Frictions and Optimal Monetary Policy." http://www.columbia.edu/~mw2230 /credit_0709.

Cúrdia, Vasco, and Michael Woodford. 2010a. "Credit Spreads and Monetary Policy," *Journal of Money, Credit and Banking,* 42(6, Supp.): 3–35.

Cúrdia, Vasco, and Michael Woodford. 2010b. "The Central-Bank Balance Sheet as an Instrument of Monetary Policy." NBER Working Paper 16208.

Dubecq, Simon, Benoit Mojon, and Xavier Ragot. 2009. "Fuzzy Capital Requirements, Risk Shifting, and the Risk-Taking Channel of Monetary Policy." Banque de France Working Paper 254. http://www.banquedefrance.fr/gb/publications /telechar/ner/DT254.pdf.

Friedman, Milton. 1968. "The Role of Monetary Policy." *American Economic Review,* 58(1): 1–17.

Friedman, Milton, and Anna J. Schwartz. 1963. *A Monetary History of the United States, 1867–1960.* Princeton: Princeton University Press.

Gagnon, Joseph, Matthew Raskin, Julie Remache, and Brian Sack. 2010. "Large-Scale Asset Purchases by the Federal Reserve: Did They Work?" Federal Reserve Bank of New York Staff Report 441.

Gârleanu, Nicolae, and Lasse Heje Pedersen. 2010. "Margin-Based Asset Pricing and Deviations from the Law of One Price." http://pages.stern.nyu .edu/~lpederse/papers/MarginPricingLoOP.pdf.

Gaspar, Vitor, and Anil K. Kashyap. 2006. "Stability First: Reflections Inspired by Otmar Issing's Success as the ECB's Chief Economist." In *Monetary Policy: A Journey from Theory to Practice,* 86–118. Frankfurt: European Central Bank.

Geanakoplos, John. 1997. "Promises, Promises." In *The Economy as an Evolving Complex System II,* ed. W. B. Arthur, S. N. Durlauf. and D. A. Lane, 285–320. Reading, MA: Addison Wesley.

Geanakoplos, John. 2003. "Liquidity, Default and Crashes: Endogenous Contracts in General Equilibrium." Chap. 5 in *Advances in Economics and Econometrics, Theory and Applications II,* ed. M. Dewatripont, L. P. Hansen, and S. J. Turnovsky. Cambridge, Cambridge University Press.

Geanakoplos, John. 2010. "The Leverage Cycle." In *NBER Macroeconomics Annual 2009,* ed. D. Acemoglu, K. Rogoff, and M. Woodford, 1–65. Chicago: University of Chicago Press.

Gerali, Andrea, Stefano Neri, Luca Sessa, and Federico M. Signoretti. 2010. "Credit and Banking in a DSGE Model of the Euro Area." *Journal of Money, Credit and Banking,* 42(S1): 107–141.

Gertler, Mark, and Peter Karadi. 2010. "A Model of Unconventional Monetary Policy." http://www .carnegie-rochester.rochester.edu/april10-pdfs /Gertler%20Karadi.pdf.

Gertler, Mark, and Nobuhiro Kiyotaki. Forthcoming. "Financial Intermediation and Credit Policy in Business Cycle Analysis." In *Handbook of Monetary Economics,* vol. 3, ed. B. M. Friedman and M. Woodford. Amsterdam: Elsevier.

Giavazzi, Francesco. 2008. "Why Does the Spread between LIBOR and Expected Future Policy Rates Persist, and Should Central Banks Do Something About It?" VoxEU.org, posted June 2.

Gilchrist, Simon, Alberto Ortiz, and Egon

Zakrajsek. 2009. "Credit Risk and the Macroeconomy: Evidence from an Estimated DSGE Model." http://sws.bu.edu/aortizb/Credit%20Risk%20and%20the%20Macroeconomy%20Gilchrist%20Ortiz%20%20Zakrajsek.pdf.

Goodfriend, Marvin, and Bennett T. McCallum. 2007. "Banking and Interest Rates in Monetary Policy Analysis: A Quantitative Exploration." *Journal of Monetary Economics,* 54(5): 1480–1507.

Gorton, Gary B., and Andrew Metrick. 2009. "Haircuts." NBER Working Paper 15273.

Greenlaw, David, Jan Hatzius, Anil K. Kashyap, and Hyun Song Shin. 2008. *Leveraged Losses: Lessons from the Mortgage Market Meltdown.* U.S. Monetary Policy Forum Report No. 2. Chicago: University of Chicago Booth School of Business.

Kacperczyk, Marcin, and Philipp Schnabl. 2010. "When Safe Proved Risky: Commercial Paper during the Financial Crisis of 2007–2009." *Journal of Economic Perspectives,* 24(1): 29–50.

Kashyap, Anil, and Jeremy Stein. 1994. "Monetary Policy and Bank Lending." In *Monetary Policy,* ed. N. G. Mankiw, 221–56. Chicago: University of Chicago Press.

Kim, Don H., and Jonathan H. Wright. 2005. "An Arbitrage-Free Three-Factor Term Structure Model and the Recent Behavior of Long-Term Yields and Distant-Horizon Forward Rates." Finance and Economics Discussion Series No. 2005-33, Federal Reserve Board, August.

Kiyotaki, Nobuhiro, and John Moore. 1997. "Credit Cycles." *Journal of Political Economy,* 105(2): 211–48.

Romer, David. 2000. "Keynesian Macro-economics without the LM Curve." *Journal of Economic Perspectives,* 14(2): 149–69.

Sarkar, Asani. 2009. "Liquidity Risk, Credit Risk, and the Federal Reserve's Responses to the Crisis." *Financial Markets and Portfolio Management,* 23(4): 335–48.

Smant, David. 2002. "Bank Credit in the Transmission of Monetary Policy: A Critical Review of the Issues and Evidence." MRPA paper 19816, Munich Personal RePEc Archive.

Taylor, John B. 1993. "Discretion versus Policy Rules in Practice." *Carnegie-Rochester Conference Series on Public Policy,* vol. 39, pp 195–214.

Taylor, John B. 2008. "Monetary Policy and the State of the Economy." Testimony before the Committee on Financial Services, U.S. House of Representatives, February 26.

Taylor, John B. 2009. *Getting Off Track: How Government Actions and Interventions Caused, Prolonged, and Worsened the Financial Crisis.* Stanford: Hoover Press.

Taylor, John B., and John C. Williams. 2009. "A Black Swan in the Money Market," *American Economic Journal: Macroeconomics,* 1(1): 58–83.

Woodford, Michael. 2003. *Interest and Prices: Foundations of a Theory of Monetary Policy.* Princeton: Princeton University Press.

Woodford, Michael. 2007. "The Case for Forecast Targeting as a Monetary Policy Strategy." *Journal of Economic Perspectives,* 21(4): 3–24.

Zigrand, Jean-Pierre, Hyun Song Shin, and Jon Danielsson. 2010. "Risk Appetite and Endogenous Risk." Financial Markets Group Discussion Paper 647.

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