Monetary Policy, Financial Conditions, and Financial Stability*

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We review a growing literature that incorporates endogenous risk premiums and risk-taking in the conduct of monetary policy. Accommodative policy can create an intertemporal tradeoff between improving current financial conditions at a cost of increasing future financial vulnerabilities. In the United States, structural and cyclical macroprudential tools to reduce vulnerabilities at banks are being implemented, but may not be sufficient because activities can migrate and there are limited tools for non-bank intermediaries or for borrowers. While monetary policy itself can influence vulnerabilities, its efficacy as a tool will depend on the costs of tighter policy on activity and inflation. We highlight how adding a risk-taking channel to traditional transmission channels could significantly alter a cost-benefit calculation for using monetary policy, and that considering risks to financial stability—as downside risks to employment—is consistent with the dual mandate.

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1. Introduction

Monetary policy works by affecting financial conditions. This paper addresses how monetary policy also affects financial stability, and the roles for macroprudential and monetary policies for reducing risks to financial stability. A growing body of research indicates that accommodative monetary policy given financial frictions can increase risks to financial stability by leading to buildups of financial vulnerabilities, which can increase future downside risks to the real economy.[1] In particular, recent research is advancing on how accommodative monetary policy and compressed risk premiums on assets affect financial vulnerabilities, such as excess credit of households and businesses, and high leverage or maturity transformation at financial intermediaries. In addition, because accommodative policy can create an intertemporal tradeoff between improving current financial conditions and increasing future financial vulnerabilities, consideration should be given to risks to financial stability in the setting of monetary policy. How it should be considered will depend on its relative effectiveness and interactions with macroprudential policies.

In this paper, we provide a broad review of transmission channels of monetary policy through financial conditions and financial vulnerabilities, and document a significant role for monetary policy in the buildup of financial vulnerabilities. Financial frictions such as asymmetric information have been foundational for macro models that include credit cycles and the effects of asset prices on collateral values and borrowing constraints. Other financial frictions that could result in vulnerabilities include agency costs, institutional investor sticky nominal return targets, and financial firms' risk models and limited liability. Moreover, individual borrowers and lenders might not have incentives to take into account their effects on aggregate debt when they make their own private decisions. These financial frictions can lead to an intertemporal tradeoff between financial

[1]Financial conditions refer to broad funding conditions, including risk premia for risky assets above the risk-free term structure. When financial frictions are present, policy may need to be set tighter or easier than neutral to achieve an optimal policy outcome. Accommodative policy refers to a stance of monetary policy that is more expansionary than would be the case in the absence of financial frictions.

conditions and financial stability for setting monetary policy, where loose financial conditions based on time-varying risk premia in asset prices and risk-taking by borrowers and lenders could lead to higher future vulnerabilities that make the system more prone to amplify negative shocks.

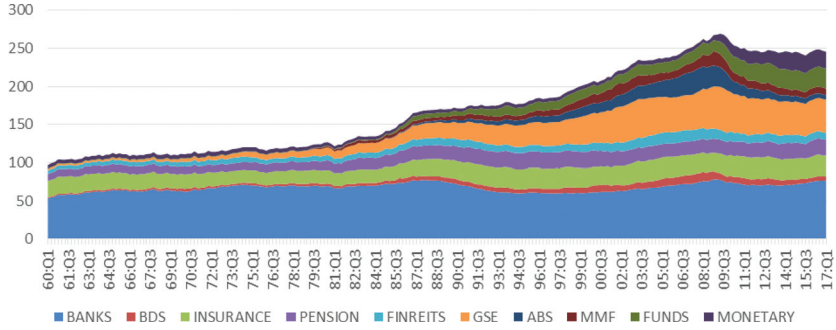
Macroprudential policies—both structural through the cycle and cyclical time varying—are usually viewed as the primary tools to mitigate vulnerabilities and promote financial stability. These regulatory and supervisory tools, such as bank capital requirements or sector-specific loan-to-value ratios, may be used to lean against the wind by tightening financial conditions in a targeted way, and to shore up the resilience of the financial system to possible adverse shocks, such as the bursting of an asset bubble.

Monetary policy works similarly to lean against the wind, though it is not targeted. It may be less efficient than macroprudential policy if the financial vulnerability is narrow. In addition, it does not directly increase resilience in the same way that higher capital at banks can. These considerations support the current prevailing approach of a clear separation in responsibilities: Monetary policy should focus on the inflation–real activity tradeoff, and, conditional on the stance of monetary policy, macroprudential policy should be used to mitigate vulnerabilities to achieve an acceptable level of systemic risk.

Proponents of an alternative non-separable approach point to the effects that monetary policy has on financial vulnerabilities in addition to financial conditions. They also would point out that macroprudential policies may have limited reach to regulated financial firms, and restricting their activities may simply push the activities into a non-prudentially regulated sector. In the United States, this sector is extensive: non-financial credit market debt held by non-bank financial firms greatly exceeds debt held by banks (figure 1 and Adrian, Covitz, and Liang 2015). Debt held by non-banks, which includes securitizations and entities funded by short-term liabilities, hit a peak in 2008 at over 100 percent of GDP, larger than the debt held by banks.

In contrast to macroprudential policies, monetary policy will affect costs for all borrowers and lenders—it "gets in all the cracks" (Stein 2014). Moreover, monetary policy is less subject to the criticism that regulators are making non-market credit-allocation

Figure 1. Credit Market Debt Outstanding (percent of GDP)



Source: Financial Accounts of the United States.

Note: Shaded areas appear in color in the online version, available at http://www.ijcb.org.

decisions. Relatedly, monetary and macroprudential policies should not be separated given their similar transmission channels to the real economy through asset prices, credit, and financial intermediation, and the policy stance of one affects the effectiveness of the other.

The clean separation view is supported by cost-benefit analysis of a "lean-against-the-wind" policy in Svensson (2016). In that framework, the costs of monetary policy to lean against the wind are a higher unemployment rate in the current period, and the benefits are reduced borrowing by households, which leads to a lower probability of a financial crisis in the future, an explicit recognition of an intertemporal tradeoff. He concludes the costs greatly exceed the benefits, based on parameters from the Swedish economy on credit growth to monetary policy and estimates of the probability of a crisis based on Schularick and Taylor (2012). Ajello et al. (2016) allow for monetary policy to reduce the probability of a crisis in a DSGE model, and they find some role for adjusting monetary policy based on the U.S. economy, but by very little given that the probability and the elasticity with respect to monetary policy is small. Gourio, Kashyap, and Sim (2016) examine the welfare implications for using monetary policy to lean against the wind, and derive positive net benefits when the costs of financial crises lead to plausibly large permanent losses in output.

Our paper is a contribution to this debate. We provide a review of current research on the effects of monetary policy on financial vulnerabilities through an endogenous increase in risk-taking, channels not typically considered in traditional macro models. This review creates a strong case against the conclusion that the costs of a lean-against-the-wind policy would always greatly exceed the benefits. We then review the research on roles for macroprudential and monetary policy to mitigate vulnerabilities, including the limitations of macroprudential policies in market-based financial systems. Finally, we present analysis of the costs and benefits of using monetary policy to lean against the wind, by using Svensson's (2016) cost-benefit framework. We use this framework because it offers a very transparent way to highlight some key assumptions that are critical to estimating the costs and benefits—specifically, about the severity of a crisis, the likelihood of a crisis, and its sensitivity to monetary policy if monetary policy is used preemptively. While we show that the net cost calculation is sensitive to assumptions, the primary objective of the analysis is to highlight that more research is needed to better quantify the magnitude of monetary policy on financial vulnerabilities through asset prices and endogenous risk-taking.

The remainder of the paper is organized as follows. Section 2 provides a conceptual framework for the relationship between monetary policy, financial conditions, and financial vulnerabilities, also considering macroprudential policy. Section 3 reviews recent literature on the transmission channels of monetary policy, particularly focusing on the potential buildup of financial vulnerabilities, using the financial stability monitoring framework described by Adrian, Covitz, and Liang (2015), as summarized in table 1. It focuses on specific financial vulnerabilities—pricing of risk, leverage, maturity and liquidity transformation, and interconnectedness and complexity—across four sectors—(i) asset markets, (ii) the banking sector, (iii) shadow banking, and (iv) the non-financial sector. Section 4 discusses how macroprudential policy tools can address financial vulnerabilities. Section 5 reviews papers that consider the interactions of macroprudential and monetary policies. Section 6 provides the cost-benefit analysis. Section 7 concludes.

Table 1. Monitoring Vulnerabilities in Different Sectors (Adrian, Covitz, and Liang 2015)

Sectors	Price of Risk	Leverage	Maturity/Liquidity Transformation	Interconnections and Complexity
Non-financial Sector	Underwriting standards (LTVs, DTIs)	Credit-to-GDP Leverage and debt service burdens of households, business, and government	Use of short-term or floating-rate debt	
Asset Markets	Risk premiums and non-price terms in equities, credit, real estate Term premiums for rates	Investor leverage	Dealer-based finance Carry trades Mutual funds ETFs	Derivatives and counterparties
Banking Sector	Risk-taking in credit and rates Underwriting standards	Regulatory capital ratios, banks and broker-dealers Market measures of risk and capital Post-stress capital from stress tests	Financial firm liabilities, maturities Secured and unsecured funding	Intrafinancial assets and liabilities Common asset holdings, correlated risks Size, critical functions,
Shadow Banks, Financial Markets	Securities issuance Underwriting standards	Securitization tranches Regulatory capital arbitrage Hedge funds Use of derivatives to mimic leverage	Agency REITs ABCP conduits Repo markets Securities lending MMFs STIFs	CCPs New financial products

2. Conceptual Framework for Monetary Policy and Financial Stability

This section describes in more detail the framework for an intertemporal tradeoff between financial conditions and financial vulnerabilities for monetary policy. This tradeoff is typically not considered in the literature on monetary policy. In traditional monetary policy settings, the inflation–real activity tradeoff determines the stance of financial conditions. For example, in typical New Keynesian models, the Taylor rule—which describes the stance of monetary policy with respect to inflation and real activity—is derived by taking first-order approximations around the steady state, thus explicitly abstracting from downside risk considerations.

As discussed in detail in this paper, when financial intermediation is added to these models, interest rate changes can also affect loan supply through credit market frictions, such as asymmetric information between borrowers and lenders that gives rise to an external finance premium. The size of the external finance premium depends on the balance sheet conditions of the borrower: When monetary policy is loose and asset values are high, higher net worth of borrowers eases borrowing constraints and allows for excess credit accumulation. In addition, accommodative monetary policy may lead to an increase in risk-taking by financial institutions and investors: Low interest rates could incent investors who have nominal return targets to reach for yield. Low rates could pressure profit margins of banks and incent them to hold riskier assets, or higher asset values could lead them to underestimate risk, given their risk-management models and limited-liability corporate structures. Low rates that boost asset values also may incent carry trades based on short-term funding, often secured by the assets, and allow for excessive maturity transformation. These channels for monetary policy lead to an increase in vulnerabilities, leaving the financial system less resilient to adverse shocks and hence raising future risks to financial stability.

Cost-benefit analysis is a useful framework to contrast the traditional models with those that consider financial intermediation. In traditional models without financial frictions, increases in credit would reflect improved economic fundamentals, and the costs of using monetary policy to reduce credit and the probability of a crisis would far exceed the benefits. But in models with financial

intermediation and frictions that lead to financial vulnerabilities, there may be net benefits to using monetary policy since less credit and lower asset valuations could reduce the probability and severity of a future recession.

This framing highlights a few issues that are important for this paper. First, financial conditions and financial stability are not the same. Declining asset prices and higher volatility due to downward revisions to expected cash flows are a deterioration in financial conditions, not signs of financial instability. A financial system that is performing its function to allocate capital to its best uses, without the fragilities of borrowers or lenders to amplify revisions to the outlook, is a stable financial system. That is, financial stability reflects a resilient financial system that is less likely to amplify adverse shocks; financial instability arises when negative shocks are amplified by vulnerabilities, leading to non-linear outcomes and tail events.

In addition, monetary policy works through financial conditions on expected economic outcomes, but risks to financial stability involve potential tail risks. The tail risks to future macroeconomic outcomes manifest only in some states of the world, when adverse shocks are realized. These dimensions are important because they greatly complicate efforts to incorporate financial stability in the determination of monetary policy. Policymakers would need to look beyond expected conditions for downside risks that arise with uncertain probability in the future. Thus such outcomes can be discounted readily, but when they occur, the consequences can be severe. Future downside risks are difficult to include in an objective function.

The distinction between vulnerabilities and risks is a fundamental one. Vulnerabilities are the amplification mechanisms that amplify adverse shocks. Risks are the realizations of adverse shocks. While the dimensionality of risks is very high—and risks are thus difficult to monitor and assess—the assessment of vulnerabilities is more manageable. The paper thus focuses on the tradeoff between financial conditions and financial vulnerabilities.

3. Monetary Policy Transmission and Financial Stability

This section reviews empirical and theoretical studies about the linkages between monetary policy, financial conditions, and financial

stability by sector. As highlighted by table 1, we could summarize the monetary policy transmission channels either by four sectors of the financial system or by vulnerabilities. We chose the former because existing studies are much more focused on sectors. In either case, however, it is the combination of vulnerabilities across sectors that increases the potential for systemic risks, rather than any individual category on its own. The monetary policy transmission channels in the four sectors for financial conditions and vulnerabilities because of financial frictions can be summarized as follows (see table 2):

- Non-financial Sector: Easier monetary policy eases borrowing constraints and boosts credit growth, but endogenous risk-taking of lenders can reduce underwriting quality and increase debt burdens of borrowers who do not consider externalities of deleveraging.
- Asset Markets: Easier monetary policy improves financial conditions by lowering the risk-free term structure and increasing risky asset prices, but agency problems and investors' reach for yield behavior can lead to compressed risk premiums and a greater risk of a price reversal.
- Banking Sector: Easier monetary policy increases lending, but endogenous risk-taking and risk-shifting can lead to higher leverage of banks and broker-dealers, and greater loan supply.
- Shadow Banking: Easier monetary policy increases financial intermediation outside the banking sector as asset prices increase, but endogenous risk-taking can lead to higher leverage and maturity transformation not backed by deposit insurance.

3.1 Non-financial Sector

3.1.1 Financial Conditions

Easier monetary policy leads to an expansion of credit by encouraging borrowing at lower interest rates. In macroeconomic models without financial-sector frictions, credit growth represents an increase in demand to finance household and business spending. The balance sheet channel is a standard transmission channel for monetary policy, which emphasizes the impact of policy on the

Table 2. Monetary Policy Transmission on Financial Conditions and Financial Stability in Different Sectors

Sectors	Financial Conditions	Financial Stability
Non-financial Sector	Borrowing conditions Balance sheet channel Credit growth or credit/GDP	Deterioriation in underwriting standards Excess leverage • Fire-sale externalities • Negative demand externalities
Asset Markets	Risk-free term structure Higher asset prices Lower risk premiums	Compressed risk premiums • Reach for yield because of nominal targets • Supported by leverage from an external finance premium, asymmetric information • Asset managers that prefer yield income or are evaluated based on relative performance Low volatility and low risk premiums • Procyclical risk-management practices • Mismeasurement of risk
Banking Sector	Credit channel	Procyclical leverage of banks and dealers • Procyclical risk-management practices and inflated collateral values Risk-shifting channel reduces the quality of credit • Low bank capital
Shadow Banks, Financial Markets	Securitization Liquidity creation Maturity transformation by non-bank intermediaries	Procyclical dealer-intermediated leverage • Procyclical risk-management practices and inflated collateral values Excessive maturity transformation • Short-term funding fragilities Regulatory arbitrage

net worth of borrowers when lenders face asymmetric information (the seminal contribution by Bernanke and Gertler 1989 was further extended by Kiyotaki and Moore 1997, and Bernanke, Gertler, and Gilchrist 1999). Empirical evidence on the balance sheet channel, often referred to as the "financial accelerator," is extensive. For example, Levin, Natalucci, and Zakrajšek (2004) find a sharp rise in external finance premiums for businesses during the 2001 recession, and Iacoviello (2005) shows that changes in home equity affect household borrowing and spending by more than a conventional wealth effect. Violations of loan covenants, which often are tied to the net worth of the borrower, may be a mechanism through which monetary policy leads to cutbacks by firms in investment and employment (Chava and Roberts 2008; Falato and Liang 2016).

3.1.2 Financial Stability

The literature generally finds that large shocks are needed for the financial accelerator to matter. Furthermore, in the financial crisis of 2007–09, borrower balance sheet frictions alone were not sufficient to explain the large observed amplification effects on the economy. As a result, the literature has been evolving to add additional frictions to explain non-financial sector credit and its interactions with other imbalances, including high asset valuations and fragile financial intermediaries.

Rapid private credit growth has been found to be a robust predictor of banking crises, and the cumulative growth as reflected in the credit-to-GDP gap for the private non-financial sector is viewed as a high-quality (high signal-to-noise) indicator for the likelihood of financial instability (see Borio and Lowe 2002, Borio, Drehmann, and Tsatsaronis 2011). Borio and Lowe (2002) suggest it is the interaction of credit and asset prices that is most costly to the economy when a credit boom unwinds, and that this combination may be a byproduct of strong demand pressures from accommodative monetary policy in a low-inflation environment when monetary policy is focused solely on price stability.

Excess credit may also arise because borrowers do not consider the externalities when making their individual borrowing decisions. Lorenzoni (2008) generates excessive borrowing ex ante and excess volatility in investment ex post, due in part to limited ability to

commit to future payments. Borrowers have limited access to outside funds, so they are forced to fire-sell assets when they are hit by bad shocks. Inefficiencies arise because borrowers do not consider the general equilibrium of fire sales on asset prices. Korinek and Simsek (2016), in a model of deleveraging, show that borrowers do not take into account the negative externalities of leverage on aggregate demand when they make their own borrowing decisions, which leads to excessive credit. In their model, tighter monetary policy could be used to address aggregate demand externalities caused by leverage.

Target rates of return that lead to "reach for yield" or risk-management practices based on past volatility could also lead to excess private credit. Accommodative monetary policy in these situations could lead to lower risk premiums and increased risk-taking at lenders (as discussed below) and more credit at riskier borrowers. For example, Becker and Ivashina (2015) document that insurance companies' reach for yield behavior is more pronounced during economic expansions, which they can test because credit ratings used to determine requirements are imperfect measures of risk. They also find greater bond issuance by riskier non-financial corporations with more pronounced reach for yield by insurance firms, suggesting ex post greater systematic risk and volatility.

Whether the monetary policy transmission channel to excess credit is direct or indirect through financial intermediaries, the consequences of a forced unwind of excess private-sector credit are substantial. Jordà, Schularick, and Taylor (2013), in a cross-section study, show that excess credit growth in the period preceding a business-cycle peak tends to be associated with more severe recessions, in both normal recessions and those associated with financial crises. In a study of private non-financial credit in the United States, Aikman et al. (2016) find in a threshold VAR analysis that the implications of greater financial conditions (investor risk appetite) and the credit-to-GDP gap depend on whether the credit gap is above or below its trend. When it is below trend, looser financial conditions lead to a sustained economic expansion and a modest increase in the credit gap. However, when the gap is above trend, looser financial conditions lead initially to an expansion, but over time lead to a sharp increase in an already-high credit gap, which sets the stage for an unwind and a recession.

In the household sector, Mian and Sufi (2009) show that a rise in household leverage measured at the county level, likely due to an increase in the supply of credit, is a strong predictor of recession severity. Mian and Sufi (2011) show that borrowing against home equity was responsible for a significant share of the rise in leverage, and subsequent new defaults. Moreover, Mian and Sufi (2012) suggest that lower demand driven by the deterioration in household balance sheets is responsible for a large share of job losses during 2007–09. For businesses, those that are more leveraged are forced to make larger cuts in investment and employment upon default or loan covenant violations (Opler and Titman 1994; Chava and Roberts 2008; Falato and Liang 2016).

Credit stresses at households and businesses also can lead to mounting losses at financial institutions. Such losses that impair capital adequacy of regulated banks and shadow banks can restrict credit availability and further reduce aggregate demand through an adverse feedback loop in which less aggregate demand reduces the value of collateral and makes it more difficult for the non-financial sector to service their debt, further increasing losses to the financial sector (Brunnermeier and Sannikov 2014a).

3.2 Asset Markets

3.2.1 Financial Conditions

The most direct transmission channel of monetary policy is via the expected path of future short rates. Monetary policy also affects the pricing of risky assets, such as in equity, credit, housing, and other risky asset markets, through expected cash flows and risk premia. Bernanke and Kuttner (2005) document that positive monetary policy surprises generate negative stock returns, not mostly through the effects on real rates but through its effects on expected returns or expected future dividends. In addition, others have shown that easing of monetary policy tends to reduce credit risk premiums on corporate bonds (Gertler and Karadi 2013; Greenwood and Hanson 2013; Gilchrist, López-Salido, and Zakrajšek 2015). Bekaert, Hoerova, and Lo Duca (2013) find, based on the dynamics of the VIX, that tightening shocks lead to increases in investor risk aversion.

Moreover, a number of studies document that the majority of movements in asset prices reflects movements in the equilibrium compensation for risk. For example, the time variation in Treasury returns primarily is due to changes in the pricing of risk rather than to changes in expectations of future short rates (see Campbell and Shiller 1984, Cochrane and Piazzesi 2005, and Cochrane 2011). Similarly, the majority of variation in credit spreads is due to investors' compensation for the risk of potential credit losses in the future rather than expected losses (see, e.g., Elton et al. 2001 and Huang and Huang 2012). For equity prices and house prices, valuation measures such as the dividend payout or the price-to-rent ratio tend to exhibit swings that are larger than can be explained by fundamentals (see Campbell and Shiller 1988 for equity returns, and Case and Shiller 2003 and Campbell et al. 2009 for house prices).

But the link from monetary policy to asset prices does not necessarily suggest that loose policy increases risks to financial stability. For that to happen, compression in risk premiums must be accompanied by a buildup of other financial imbalances. We turn to a discussion of these issues next.

3.2.2 Financial Stability

High valuation levels in asset markets are a financial vulnerability if combined with leverage and maturity transformation of financial-sector lenders or high credit of non-financial borrowers that could lead to an asymmetric unwinding of risk premiums.[2] Of course, it is difficult to assess in real time when valuation levels are excessive; this can only be judged by historical standards using asset pricing models. For example, in the run-up of equity market valuations in the late 1990s, many argued that the very high price-earnings ratios were justified by a structural break in productivity. Similarly, in the run-up of house prices in the early to mid-2000s, many argued that high price-to-rent ratios were sustainable because of improved credit intermediation technologies and less volatile household income. In our monitoring approach, high valuations that are supported by

[2]Early literature on monetary policy and asset price bubbles considered such bubbles without consideration of financial frictions (e.g., Bernanke and Gertler 1999). We discuss that literature in detail in section 5.

structural breaks, because "this time is different," would represent a vulnerability that warrants additional attention. In particular, rather than focusing on whether or not valuation levels can be justified, the focus should be on potential systemic consequences if prices were to fall. Asset pricing models for interest rates, credit products, real estate, and equities are needed to assess valuations and are an important first step in assessing overall system vulnerabilities.

Accommodative monetary policy combined with financial frictions may lead to high valuations and compressed risk premiums for financial assets for a number of reasons. Rajan (2005, 2006) argues that low interest rates can lead to compressed risk premiums because they increase the incentives for investors to "reach for yield." This incentive arises because some investors operate with constraints, such as fixed nominal rate targets tied to their liabilities, or asset managers have contractual arrangements in which their compensation is based on returns above a nominal level. For Treasury securities, looser monetary policy, combined with investor behavior, can lead to lower real term premiums for Treasury securities than can be justified by fundamentals. Hanson and Stein (2015) provide evidence that monetary policy shocks induce sizable effects on distant forward real rates, likely due to lower term premiums, which they show is consistent with yield-oriented investors who prefer current income to a holding-period return. When monetary policy loosens, these investors rebalance to longer-term bonds, so as to mitigate a decline in current yields, thereby boosting longer-term bond prices and reducing term premiums. This mechanism is similar to unconventional monetary policy, such as asset purchases of Treasury securities, which work by lowering term premiums. It represents a potential risk to financial stability if combined with leverage and maturity transformation.

Monetary policy also could lead to a compression of risk premiums by increasing risk-taking at financial institutions. In theoretical contributions, Allen and Gale (2000, 2004) provide models where bubbles in real estate prices can arise because of agency problems between investors and lenders (risk-shifting because lenders do not observe the risky investment), and as credit expands. Low interest rates can encourage investors to purchase a risky asset, boosting its current price. The expectation of future credit expansion will also raise current prices, though at the same time increasing the

likelihood of a future crisis. They argue that expectations about future credit are determined by monetary policy.

Adrian and Shin (2008) focus on the empirical relationship between monetary policy, asset prices, and financial intermediaries. Looser monetary policy increases the ability of intermediaries to take on leverage, which in turn affects the pricing of risk (see also Adrian, Moench, and Shin 2010 and Adrian, Etula, and Muir 2014). This evidence suggests that loose monetary policy fuels risk-taking, which in turn leads to a lower price of risk and lower contemporaneous risk. However, that compression in risk and the pricing of risk tends to increase forward-looking risk, as it fuels leverage due to lax risk-management constraints, giving rise to financial stability concerns as low risk premia and low volatility thus contribute to a buildup in imbalances, which is referred to as the "volatility paradox" (Brunnermeier and Sannikov 2014b).

Feroli et al. (2014) and Morris and Shin (2014) posit that unlevered asset managers who are evaluated based on their relative performance provide a channel for monetary policy to generate sharp rises in risk premia not related to changes in fundamentals. Loose monetary policy may lead to greater flows to funds that are managed by asset managers, who want to avoid being the worst performer since investors can redeem assets. Fund flows lead to increases in prices, generating momentum and a feedback loop between flows and prices. But when investors believe monetary policy may tighten, the aversion by asset managers to underperformance can create a sharp jump in risk premia. They document this channel for risky bonds, though they do not find empirical support in Treasuries or equities.[3]

Accommodative monetary policy in a setting with financial frictions can lead to sharper declines in prices in the event of adverse shocks than if risk premiums were constant or unrelated to those frictions. In addition, time-varying risk premia suggest that periods of compressed risk premia can be expected to be followed by a reversal of valuations (He and Krishnamurthy 2013). López-Salido, Stein, Zakraješek (2016) test this hypothesis directly. Periods of narrow risk premiums for corporate bonds and high issuance of low-rated

[3]Even so, more work is needed to determine if the jumps in risk premia are sufficiently large to pose a threat to financial stability in the absence of high leverage and maturity transformation in the broader financial system.

bonds are useful predictors of negative investor returns in the subsequent two years, building on Greenwood and Hanson (2013). The negative returns in turn lead to a contraction in output, which likely is due to a pullback in credit supply. Their study provides direct evidence of an intertemporal tradeoff between accommodative current financial conditions at some future cost to economic output. In addition, Claessens, Kose, and Terrones (2012) show that recessions associated with house price or equity price busts tend to be both longer and deeper than other recessions. Their study analyzes forty-four countries from 1960 to 2010 and finds this pattern for both advanced and emerging economies.

3.3 Banking Sector

3.3.1 Financial Conditions

Besides its impact on asset valuations, monetary policy has traditionally been viewed to work through the banking sector, mainly as lower policy rates lead to an increase in the volume of lending (see Peek and Rosengren 2013 for a review). The bank lending channel posits that easier policy relaxes borrowing constraints of banks, shifting credit supply (Bernanke and Blinder 1988; Kashyap and Stein 1994). Bernanke and Blinder (1992), Kashyap, Stein, and Wilcox (1993), and Bernanke and Gertler (1995) provide empirical support for the bank lending and balance sheet channels, based on aggregate data, as monetary policy tightening lead banks to shrink lending. Kashyap and Stein (1995, 2000) show that banks that are small and less liquid, and have fewer margins to adjust to a loss of reservable deposits, reduce loans by more when policy tightens. While many studies support the lending channel, recent developments in financial markets, such as growth of securitization, suggest that the channel through banks may have become less of an amplification channel for monetary policy (Loutskina and Strahan 2009).

Capital requirements may influence the impact of monetary policy on bank lending. Peek and Rosengren (1995) show that an adverse capital shock that makes a capital constraint binding will cause banks to shrink assets and liabilities. When comparing capital-constrained to unconstrained banks, the unconstrained were more able to increase loans in response to an easing of policy.

3.3.2 Financial Stability

An increasing number of papers have focused on the link between the stance of monetary policy and the risk-taking behavior of banks, which increases vulnerabilities and risks to financial stability. Loose monetary policy can encourage banks to take on more risk on both the asset side and the liability side. On the asset side, banks can reach for yield (Rajan 2005), which will increase the share of risky assets. On the funding side, loose monetary policy increases incentives to use more short-term funding. Adrian and Shin (2010) and Stein (2012, 2013) show that increases in policy rates are associated with declines in short-term liabilities.

Recent papers provide cross-sectional evidence of the risk-taking channel, in which monetary policy affects not just the quantity but also the quality of credit. The risk-taking effects depend importantly on the amount of bank capital, where higher levels of capital mitigate incentives to reduce the quality of credit. Jiménez et al. (2012) use detailed credit register data in Spain to show that lower rates lead to greater risk-taking and more credit to riskier firms, and this effect is greater at banks with lower capital. Dell'Ariccia, Laeven, and Suarez (2013) look at this channel in the United States and find a relationship between ex ante riskiness of loans and bank capital. Paligorova and Santos (2017) evaluate loan spreads on syndicated loans in the United States and find that required spreads for more risky to less risky borrowers are lower in periods of looser monetary policy and are stronger for banks with greater risk appetite. Maddaloni and Peydró (2011) find that low rates lead to softer lending standards in both the United States and the euro area, which is greater if rates have been low for an extended period, supervision is weaker, and securitization activity is greater. Altunbas, Gambacorta, and Marques-Ibanez (2010) show that unusually low rates for an extended period led to a sharper rise in expected default probabilities for banks, consistent with greater risk-taking.

Monetary policy also affects the leverage of financial institutions. Drechsler, Savov, and Schnabl (2014) model the effects of monetary policy by affecting the external finance spread that banks pay to leverage. Easing of monetary policy leads to lower leverage costs for banks, which increases risk-taking and lowers risk premia. They document that an external finance spread for banks (the funds rate – the

T-bill rate) moves closely with the federal funds rate. Adrian and Shin (2010, 2014) document that broker-dealer leverage is endogenous and highly procyclical, due to the way in which risk management is conducted. Adrian and Shin (2009, 2011) link the procyclical leverage to monetary policy, showing that tighter monetary policy tends to lower risk-taking of broker-dealers, leading to an increase in the pricing of risk, with associated contractionary macro consequences. In addition, Adrian, Moench and Shin (2010) link leverage management to aggregate economic activity, and show that shocks to dealer leverage impact macro activity through the pricing of risk. Adrian and Boyarchenko (2012) and Nuño and Thomas (2014) provide theories that rationalize these facts within dynamic stochastic general equilibrium (DSGE) models. In Adrian and Boyarchenko (2012), higher leverage is further associated with an increase in financial vulnerability in the form of systemic risk.

3.4 Shadow Banking

3.4.1 Financial Conditions

Shadow banking can be defined as maturity transformation, liquidity transformation, and credit risk transfer outside of institutions with direct access to government backstops such as depository institutions (see Adrian, Ashcraft, and Cetorelli 2013 for a recent overview). This intermediation takes place in an environment where prudential regulatory standards and supervisory oversight are either not applied or are applied to a materially lesser or different degree than is the case for regulated banks. The shadow banking system decomposes credit intermediation into a chain of wholesale-funded, securitization-based lending.[4]

[4]Shadow credit intermediation is performed through chains of non-bank financial intermediaries in a multi-step process that can be interpreted as a "vertical slicing" of the traditional banks' credit intermediation process into seven steps. Pozsar et al. (2013) explain the seven steps of shadow bank credit intermediation in detail. The seven steps involve (i) loan origination, (ii) loan warehousing, (iii) pooling and structuring of loans into term asset-backed securities (ABS), (iv) ABS warehousing, (v) pooling and structuring of ABS into collateralized debt obligations, (vi) ABS intermediation, and (vii) funding in wholesale funding markets by money market intermediaries.

The shadow banking system transforms risky, long-term loans (mortgages, for example) into seemingly credit-risk-free, short-term, money-like instruments. The creation of money-like shadow bank liabilities complements traditional forms of money creation (Gorton and Metrick 2012). High-powered money can be created only by central banks. Commercial banks create broader forms of money, such as demand deposits. Shadow bank money creation occurs primarily in the commercial paper market and the repo market, and is funded by money market funds and short-term investment funds. Shadow bank liabilities can substitute for money in the private sector's asset allocation. Sunderam (2015) shows that shadow banking liabilities respond to money demand shocks. Gallin (2013) provides a comprehensive map of the amount of short-term funding from the shadow banking system to the real economy, based on the flow of funds statistics. Short-term money creation by the shadow banking system also furthers monetary policy transmission.

Money creation in the shadow banking system is at the root of the breakdown of monetary relationships in the United States. Until the early 1980s, the relationship between money growth and nominal output growth was very stable, a fact usually labeled the stable velocity of money. Schularick and Taylor (2012) document that credit began to grow rapidly and decouple from broad money since the early 1970s, via a combination of increased financial risk and leverage outside of non-monetary liabilities at banks. Since the shadow banking system became a quantitatively important contributor to credit intermediation, shadow bank money creation has led to a highly time-varying velocity of money. This reflects the feature of the shadow banking system that it responds quickly to changing financial, economic, and regulatory conditions.

3.4.2 Financial Stability

The shadow banking system, which is less constrained than banks by prudential regulation, leads to a greater transmission of monetary policy through a higher degree of endogenous risk-taking. The greater risk-taking may be evident in higher leverage, and greater maturity and liquidity transformation, allowing the system to operate at higher levels of risk-taking and increasing the potential for systemic financial crises (see, e.g., Brunnermeier and Pedersen 2009;

Geanakoplos 2010) The presence of shadow banking thus steepens the risk–return tradeoff relative to an economy with only traditional banking, making monetary transmission faster but also riskier.

A generic model of shadow bank intermediation that features such a steepening in the aggregate risk–return tradeoff has been proposed by Moreira and Savov (2013). Intermediaries create liquidity in the shadow banking system by levering up the collateral value of their assets. However, the liquidity creation comes at the cost of financial fragility, as fluctuations in uncertainty cause a flight to quality from shadow liabilities to safe assets.[5]

Per definition, funding sources for shadow banking activities are uninsured and thus runnable. In many ways, the fragility of shadow banks due to runnable liabilities resembles the banking system of the nineteenth century, prior to the creation of the Federal Reserve and the Federal Deposit Insurance Corporation. During that time, bank runs were common, and they often had severe consequences for the real economy. The shadow banking system's vulnerability to runs bears resemblance to bank runs as modeled by Diamond and Dybvig (1983). Shadow banks are subject to runs because assets have longer maturities than liabilities and tend to be less liquid as well. Gorton and Metrick (2012) document the run on the shadow banking system at the beginning of the financial crisis of 2007–09, as investors began to question the value of subprime mortgage collateral. Covitz, Liang, and Suarez (2013) show that ABCP programs that held subprime mortgage securities were more likely to be run if they had weaker liquidity and credit support, as commercial paper investors are especially sensitive to being paid in full and on time. Moreover, for programs able to issue paper, spreads were wider and maturities were shorter, pointing out their inherent fragility and source of financial instability.

In a run, shadow banking entities have to sell assets at a discount, which depresses market pricing. Martin, Skeie, and von Thadden (2012) provide a model for a run in repo markets. In their model,

[5]ABCP since 2004 was—at least in part—attributable to regulatory arbitrage triggered by a change in capital rules. Acharya, Schnabl, and Suarez (2013) document that the majority of guarantees were structured as liquidity-enhancing guarantees aimed at minimizing regulatory capital, instead of credit guarantees, and that the majority of conduits were supported by commercial banks subject to the most stringent capital requirements.

repo borrowers face constraints due to the scarcity of collateral and the liquidity of collateral. Under sufficiently adverse conditions, self-fulfilling runs can occur. Duarte and Eisenbach (2013) quantify repo runs and find large spillovers, with potentially systemic effects.

Another source of financial stability risk emanating from shadow banking is related to the perception of tail risk. Misperceived tail risk matters for monetary policy, as it affects estimates of downside risk to real activity and inflation. An early paper warning of the financial system's exposure to such tail risk was presented by Rajan (2005), who asked whether financial innovation had made the world riskier. Rajan (2006) later notes that financial intermediaries have incentives to show superior performance in periods when financing is ample, which leads them to take on tail risk. Shadow banking activity is often tailored to take advantage of mispriced tail risk, making the shadow banking system particularly sensitive to tail events. Such tail risk might be mispriced ex ante, either due to irrational or due to rational reasons. Gennaioli, Shleifer, and Vishny (2013) posit that actors neglect risk based on behavioral evidence. When investors systematically ignore the worst state of the world, overinvestment and overpricing during the boom and excessive collapse of real activity and the financial sector during the bust are generic features of shadow credit intermediation.

Coval, Jurek, and Stafford (2009) point out that the AAA tranches of private-label asset-backed securities behave like catastrophe bonds that load on a systemic risk state. Neglected risk also manifests itself through overreliance on credit ratings by investors. For example, Ashcraft et al. (2011) document that subprime MBS prices are more sensitive to ratings than ex post performance, suggesting that funding is excessively sensitive to credit ratings relative to informational content. Merrill, Nadauld, and Strahan (2014) show that life insurance companies with low capital that were exposed to unrealized losses in the early 2000s increased their holdings of highly rated securitized assets which offered higher yield per unit of required capital, reflecting perhaps neglected tail risks. In contrast, Chodorow-Reich (2014) finds only limited evidence of reach for yield behavior at financial institutions: for money market funds, the interaction of low nominal interest rates and administrative costs forced the funds to waive fees; funds with higher costs reached for higher returns in 2009–11, but not thereafter.

4. Macroprudential Policies

This review of papers provides considerable evidence that monetary policy affects the buildup of vulnerabilities—narrow risk premiums, excess credit at borrowers, and higher leverage and more fragile funding in the financial sector. However, adjustments to monetary policy to reduce these vulnerabilities may at times come into conflict with its primary mandates to achieve price stability and full employment.

Macroprudential policies can improve the intertemporal trade-off for monetary policy by preemptively lowering vulnerabilities of the financial system. For example, increasing capital requirements may reduce risk-shifting by insufficiently capitalized banks that leads to lower quality loans and increases vulnerabilities. Higher capital could be set through enhanced structural requirements, but may be more costly than a cyclical time-varying capital requirement, since it will remain at its constant high level at a credit-cycle peak, when investors and firms already are highly risk averse and reluctant to extend credit. However, decisions to implement cyclical policies raise difficult timing issues for policymakers, and may be subject to the criticism that macroprudential authorities are raising capital requirements to restrict credit by too much when future costs to financial stability are highly uncertain or that they are releasing capital too soon when concerns about bank default are still high.

Cyclical policies vary widely by their implementation costs: Relatively inexpensive actions include increased supervisory scrutiny targeted to specific firms and activities, communications by authorities, or public recommendations by financial stability coordinating or decision bodies (such as the Financial Stability Oversight Council in the United States or the Financial Policy Committee in the United Kingdom) to regulators, financial institutions, or market participations. At the other end of the cost spectrum, a countercyclical capital buffer could imply significant capital raising and international cooperation.

This section reviews the literature on cyclical macroprudential tools. Empirical evidence is mostly from emerging market economies, which may limit the insights for advanced economies with more complex financial systems, in which leakage of activities from the regulated to unregulated sectors can undermine the effectiveness of these tools. In addition, the governance framework

for implementing such tools may vary considerably, with fewer regulators in emerging market economies than in advanced economies. Table 3 summarizes existing macroprudential tools for each of these sectors.

4.1 Non-financial Sector

Macroprudential tools to address emerging imbalances in the non-financial sector aim primarily at improving underwriting standards to reduce borrower debt. For example, increasing loan-to-value (LTV) ratios or debt-to-income (DTI) ratios on mortgages can limit the exposures of households and businesses to a collapse in prices, thereby bolstering their resilience. Theoretical evidence on the effectiveness of LTVs is mixed. Goodhart et al. (2012) study LTV limits in conjunction with capital and liquidity regulations. In their model, LTV tools are relatively ineffective in the presence of asset price booms. One reason is that as the rise in asset prices boosts collateral values, it becomes relatively easier to satisfy LTV constraints. Bianchi and Mendoza (2011) find some welfare benefits of an LTV in a model that incorporates that borrowers will borrow more than socially optimal because they do not consider a debt deflation spiral arising from binding collateral constraints based on falling asset values. But they also find that a constant high LTV can be costly because once the deflation spiral occurs, the best outcome would be to relax the borrowing constraint and allow a higher LTV.

In cross-country empirical work, Kuttner and Shim (2013) provide evidence based on fifty-seven countries that limits on debt-service-to-income ratios can help to restrain housing credit, thereby moderating the cycle, while LTVs are less successful at restraining credit growth since credit can increase with real estate values. Cerutti, Claessens, and Laeven (2017) document the use of macroprudential policies for 119 countries over the 2000–13 period, covering many instruments. Borrower-based tools can lead to a reduction of growth in credit, notably in household credit. The effects are smaller in open economies, and usage comes with greater cross-border borrowing, suggesting some avoidance. This evidence suggests that macroprudential policies can help manage financial cycles by mitigating household credit growth.

Table 3. Macroprudential Policy Tools in Different Sectors

Sectors	Financial Stability	Macroprudential Tools
Non-financial Sector	Deterioriation in underwriting standards Excess leverage • Fire-sale externalities • Negative demand externalities	Limits on underwriting standards, such as LTVs and DTIs Limits on adjustable-rate loans for borrowers, stress-test borrowers for rising rates
Asset Markets	Compressed risk premiums • Reach for yield because of nominal targets • Supported by leverage from an external finance premium, asymmetric information • Asset managers that prefer yield income or are evaluated based on relative performance Low volatility and low risk premiums • Procyclical risk-management practices • Mismeasurement of risk	Underwriting standards for debt, such as LTVs and DTIs Sectoral risk weights at banks Countercyclical capital or liquidity buffers Margins and haircuts Limits on short-term collateralized funding

(continued)

Table 3. (Continued)

Sectors	Financial Stability	Macroprudential Tools
Banking Sector	Procyclical leverage of banks and dealers • Procyclical risk-management practices and inflated collateral values Risk-shifting channel reduces the quality of credit • Low bank capital	Higher capital and liquidity requirements Countercyclical capital and liquidity requirements Sectoral risk weights Supervisory guidance, exposure limits Supervisory stress tests
Shadow Banks, Financial Markets	Procyclical dealer-intermediated leverage • Procyclical risk-management practices and inflated collateral values Excessive maturity transformation • Short-term funding fragilities Regulatory arbitrage	Reduce regulatory and accounting incentives to move activities from regulated sector Higher minimum haircuts or margins Tighter standards on securitizations

Because of significant differences across countries in financial system structures that could change the effectiveness of macroprudential tools, case studies may be a constructive analytical approach. In the United States, there is some evidence that the use of LTVs and maturity caps in the early 1950s, as imposed by the Federal Reserve Board, were effective in reducing housing starts, but Congress removed that authority, partly reflecting uneasiness with the Federal Reserve targeting particular types of credit growth (Elliott, Feldberg, and Lehnert 2013). In recent years, a number of countries have increased loan-to-value ratios on residential mortgages to limit an increase in exposures of households to a collapse in prices, and to lean against rising real estate prices. For example, Hong Kong has increased LTVs multiple times on residential mortgages in the past decade to mitigate the house price boom. As prices have continued to rise, they have also "stress-tested" borrowers for resilience to increases in interest rates. Korea imposed LTV and DTI limits on households, which appear to have reduced mortgage loans, housing transactions, and house prices in the six months after implementation. The Bank of Israel took several steps between 2009 and 2011 to rein in a housing boom, including a supplementary reserve requirement for banks' mortgage loans with high LTVs, increased capital requirements for mortgages with floating rates and high LTVs, and restricting the adjustable interest rate component of mortgage loans. Canada has employed a mix of LTV and DTI restrictions, in addition to maturity caps and mortgage insurance limits, to restrain a buildup in household leverage and house prices. With time, the experience of these efforts will be important contributions to the profession's understanding of these tools.

4.2 Asset Markets

Macroprudential tools could be used to lean against increases in asset prices or to mitigate risks from a subsequent downturn in asset prices, by tightening underwriting standards such as LTVs and DTIs. Other tools include countercyclical capital buffers, or higher risk weights or sectoral capital buffers for regulated firms. In addition, if asset prices are being fueled by leverage, standards could be tightened on implicit leverage through securitization or other risk transformations, or by limiting the debt provided to investors in

either unsecured or secured funding markets by raising margins and haircuts.

Empirical evidence of the effectiveness of macroprudential tools to lean against rising asset prices is scarce and limited to effects on house prices. Kuttner and Shim (2012) find that LTVs and exposure limits at financial institutions may help to reduce house price growth, using a sample of actions in fifty-seven countries. Looking at recent specific cases, the use of LTV limits combined with other actions in Hong Kong, Korea, and Canada may have mitigated some growth in house prices (Almeida, Campello, and Liu 2006; Igan and Kang 2011; Wong et al. 2011). Kuttner and Shim (2013) in a later study show for the same countries that low short-term interest rates contribute to house price increases and credit growth, but cannot account fully for the booms and busts. Dokko et al. (2009) show that monetary policy deviations from the Taylor rule explain only a small part of the rise in house prices in the United States leading up to the financial crisis.

To mitigate the consequences of an asset price boom and bust, the set of macroprudential tools available are basically designed to reduce leverage and unstable funding at financial firms and at borrowers.

4.3 Banking Sector

Macroprudential tools that could offset excessive risk-taking in banking include the new Basel III countercyclical capital buffer, which can be built up in boom times when the cost of equity is relatively cheap and deployed in downturns when the accumulation of capital is expensive. A buildup during extended boom times would result in a higher capital buffer, leaving banks better positioned to withstand large adverse shocks. A release of the countercyclical capital buffer in a downturn would offset pressures for banks to deleverage, thus mitigating the potentially adverse amplification of forced deleveraging during an economic downturn. In principle, the buildup and release of the buffer would be a function of the pricing of risk, whereas capital required for microprudential objectives would be a function of physical default risks.[6]

[6]The Federal Reserve issued for public comments a framework for implementing countercyclical capital buffers in December 2015.

A tool that is similar to countercyclical capital requirements, but that works in a more targeted fashion, is sectoral capital requirements. Sectoral capital requirements would be built and released like a countercyclical buffer, but higher or lower capital charges would be for specific asset classes.

Other policy tools include supervisory guidance and stress tests. Supervisory guidance, which could be used to signal a need to improve risk-management practices around potential future risks, is by design flexible and can be effective (Bassett and Marsh 2014). Supervisory stress tests can address emerging vulnerabilities by adjusting the severity of the macroeconomic and financial scenarios, in practice working to offset procyclicality inherent in capital regulations (Liang 2013). Stress tests can also highlight potential salient risks, such as a sharp rise in term premiums when interest rates have been low for an extended period. However, because excessive tightening of prudential regulations for banks can be expected to push financial intermediation into the shadow banking system, especially when the pricing of risk is low, macroprudential policies aimed at systemically important financial institutions (SIFIs) should be complemented by prudential policies for the shadow banking system.

Empirical evidence is limited, since traditional microprudential tools have not really been used to achieve broader financial stability. Higher bank capital ratios are found to reduce the probability of a crisis (Anundsen et al. 2014), and a Basel Committee on Banking Supervision (2010) study finds that higher capital requirements lower tail risk, but they also lower GDP growth for a number of years. Aiyar, Calomiris, and Wieladek (2016) use U.K. minimum bank capital requirements to estimate the impact of capital on credit supply and find that bank lending reacts substantially to capital requirement changes. However, Aiyar, Calomiris, and Wieladek (2014) find substantial leakage of capital regulation as foreign banks partially offset the impact of capital requirements on bank credit supply.

An alternative way to evaluate macroprudential tools is in the context of DSGE models. Analysis of macroprudential tools in the presence of banking frictions within equilibrium models is rapidly developing. For example, Kiley and Sim (2012) examine a setting where banks face an external finance premium. Modigliani-Miller is assumed to fail so that debt is cheaper than equity and outside equity is the most expensive form of funding. The key friction in

Kiley and Sim (2012) is the pecuniary fire-sale externality across banks, reflecting bank balance sheet problems. Kiley and Sim evaluate policies to lean against credit growth, against asset prices, and against loan spreads. In particular, they analyze a procyclical capital buffer (interpreted as a tax on leverage) aimed at closing the gap between private and social costs of bank debt. In their setting, policies for loan spreads work best. While Kiley and Sim feature a monetary policy rule, they do not look at the interaction of the monetary policy rule with the macroprudential instruments.

4.4 Shadow Banking

Regulatory capital and accounting rules in the pre-crisis period had created significant incentives for banks to shift assets off balance sheet into shadow bank special-purpose entities (SPEs). Since then, bank regulatory and accounting reforms have been adopted to restrict regulatory arbitrage. For example, Basel III reforms have increased the capital charge for providing explicit support to shadow banks, assuming a higher drawdown rate under the liquidity coverage ratio for credit and liquidity facilities, and the Financial Accounting Standards Board adopted new rules that require sponsors to consolidate many previously off-balance-sheet transactions. These reforms should help reduce shadow banking that is done for the purpose of regulatory arbitrage. That said, more stringent banking regulations could also increase incentives to move some activities away from banks, especially if demand for credit or for cashlike assets strengthens.

Macroprudential policy tools that affect shadow banking are not well defined, and are very heterogeneous across entities and activities (see Adrian 2014 for a review; see also Hanson, Kashyap, and Stein 2011). While shadow banking activities are often regulated for market conduct and market functioning, most shadow banking entities and activities are not subject to prudential regulation. As a result, the availability of macroprudential policies for shadow banking is limited, though there is an international effort under way to improve shadow banking regulation.[7]

[7]The Financial Stability Board, as directed by the G-20 leaders, has been developing policy recommendations to strengthen the oversight and regulation of

One possible tool to address procyclical incentives in secured funding markets, such as repo and securities (sec) lending, is minimum standards for haircut practices, to limit the extent to which haircuts would be reduced in benign markets. Margins and haircuts effectively set the maximum amount of leverage that borrowers can take. Margins and haircuts are set by exchanges, clearinghouses, broker-dealers, and counterparties. In practice, however, such margins and haircuts are set from a purely microeconomic risk-management perspective. Macroprudential considerations would promote higher through-the-cycle margins because they could materially reduce the ability of shadow banking participants to take on excessive leverage in expansions.

Goodhart et al. (2012, 2013) consider the impact of margin constraints on shadow banks, capital and liquidity requirements on banks, and loan-to-value limits on borrowers in a dynamic equilibrium setting. The presence of a shadow banking sector generates fire-sale externalities on the banking sector and the household sectors, as haircuts tend to rise in times of stress. Limiting shadow bank leverage by setting margins preemptively can mitigate this fire-sale externality, but comes at the cost of reduced credit intermediation in the boom. Goodhart et al. do not find countercyclical capital requirements on banks to be particularly useful at preempting systemic risk in the presence of shadow bank intermediaries, as the shadow banking system can arbitrage the increased capital requirement. Instead, the joint usage of countercyclical capital requirements and countercyclical margin setting can be more effective. However, a constraint on the effectiveness of capital and margin policies is the fact that collateral values increase in asset price booms, making capital constraints ineffective as a preemptive tool, though they are still useful as a prudential instrument. For preemptive purposes, Goodhart et al. find liquidity requirements to be more effective in constraining risk-taking. However, the tightness of liquidity requirements is tightly

the shadow banking sector. The set of proposals attempt to (i) limit the spillover of shadow banking risks to the banking sector, (ii) reduce or eliminate the first-mover advantage in U.S. money market mutual funds that makes them vulnerable to runs, (iii) assess and mitigate risks of other shadow banking entities, (iv) assess and align the incentives in securitization, and (v) dampen risks and the procyclical incentives in secured financing.

linked to the stance of monetary policy, and to safe asset availability more generally.

Stein (2012) studies central bank policies in the presence of shadow bank intermediation. In Stein's setting, shadow bank intermediaries create money-like short-term debt. Due to an externality, shadow banks issue too much short-term debt, creating excess vulnerability to financial crises. Stein points out that balance sheet policies of the central bank can be a useful complement to traditional monetary policy through open market operations, as balance sheet policies affect the value to the shadow banking system of issuing short-term debt, and hence regulate the magnitude of excess vulnerability in the shadow banking system.

5. Interactions between Macroprudential and Monetary Policies

Since the transmission channels for macroprudential and monetary policies are intertwined because they affect the same variables, consideration should be given to whether monetary policy should incorporate financial stability objectives.[8] An early contribution by Bernanke and Gertler (1999) evaluates whether monetary policy should react to asset valuations. They argue for a flexible inflation-targeting regime that considers asset prices only to the extent that they affect the inflation–activity tradeoff. This view used to be accepted widely, especially with respect to equity market bubbles, as the burst of the late 1990s' tech bubble appeared to be successfully offset by easing monetary policy.

There were some exceptions to these arguments. Christiano, Motto, and Rostagno (2006) argue that monetary policy that focuses

[8]More broadly, a theory of the interdependence of macroprudential, fiscal, and monetary policies is provided by Brunnermeier and Sannikov (2011, 2014a, 2014b). Their "I Theory" stresses the importance of spillover effects that link price stability, financial stability, and fiscal stability, and the difficulties of separation of the stability concepts. For example, financial instability prompts financial intermediaries to shrink their balance sheets and create less inside money. Consequently, the money multiplier collapses and Fisher deflation pressure emerges. This increases the real value of banks' liabilities and worsens financial instability. Also, monetary policy redistributes wealth to the ailing sector by changing the relative value between government debt and money in order to stabilize the overall economy.

narrowly on inflation may inadvertently contribute to welfare-reducing boom-bust cycles in real and financial variables.[9] The authors show that a policy of monetary tightening when credit growth is strong can mitigate such problems. In addition, Christiano et al. (2010) document that stock market booms tend to be accompanied by low inflation. As a result, interest rate rules that focus narrowly on inflation targets will destabilize asset markets and the broader economy. Interest rate rules should thus be adjusted for asset valuations, for example by allowing an independent role for credit growth, to reduce the volatility of output and asset prices.

More broadly, since the financial crisis, the New Keynesian literature has focused on incorporating credit supply into monetary policy models. Gertler and Kiyotaki (2010) develop a canonical framework to analyze credit market frictions and aggregate economic activity in the context of the 2007–09 crisis, augmenting Bernanke and Gertler (1989) and Bernanke, Gertler, and Gilchrist (1999) with a financial sector. Gertler and Kiyotaki (2015) add a banking sector that features bank net worth and liquidity mismatch, which gives rise to bank runs, as in Diamond and Dybvig (1983). Woodford (2010) proposes a Keynesian IS-LM model augmented with financial intermediary frictions, based on Curdia and Woodford (2010). In that setting, the financial intermediation friction gives rise to a state variable in addition to inflation and real activity. That state variable can be mapped into credit spreads (loan less policy rate), which in turn enters into the optimal monetary policy rule. Optimal policy thus is explicitly dependent on credit supply conditions. Woodford (2011) studies optimal monetary policy in a setting with financial crises and finds that inflation-targeting rules should consider explicitly the possibility of financial crises.

Gambacorta and Signoretti (2014) compare the performance of Taylor rules augmented with asset prices and credit supply, building on the setting of Curdia and Woodford (2010), with more standard rules with flexible inflation targeting. They find that even if financial stability is not an explicit target for monetary policy, monetary policy rules that respond to borrower balance sheets and credit supply in the presence of supply shocks result in a better tradeoff

[9] See Adrian and Shin (2006) and Gertler (2006) for related arguments.

for inflation and output stabilization. In particular, indicators of financial-sector leverage should directly enter into an augmented Taylor rule, and preemptive monetary policy enhances welfare.

Gilchrist and Zakrajšek (2011, 2012) evaluate monetary policy rules that augment the Taylor rule with a credit spread. They use a New Keynesian model, augmented with the standard Bernanke, Gertler, and Gilchrist (1999) financial accelerator mechanism, which is capable of producing the dynamics of the U.S. economy during the recent financial crisis. The benefits of a monetary policy rule that incorporates credit spreads arise as asset prices anticipate the beneficial effects of such a rule in mitigating the financial frictions. In a calibration of the model to U.S. data, the spread-augmented policy rule dampens the negative consequences of financial disruptions on real economic activity, while engendering only a modest increase in inflation. López-Salido, Stein, and Zakrajšek (2016) also suggest the importance of asset prices and credit supply conditions for the setting of monetary policy.

In practice, monetary policymakers may already be considering financial stability objectives to some extent, even if these objectives are not in their explicit mandates. For example, with a simple quadratic loss objective function, policymakers would minimize the square of the expected value of the gap between output and potential output, and the variance of output (Kocherlakota 2014; Stein 2014; see also Peek, Rosengren, and Tootell 2015). Financial stability risks are reflected in the variance term. When the gap is large with actual well below potential, the variance around output would have less weight in the objective function. Moreover, looser monetary policy might also reduce the variance term, by strengthening the balance sheets of borrowers and lenders.[10] However, when the output gap is close to zero, financial stability considerations would have greater weight in reducing variance. In this situation, a tradeoff may emerge as accommodative policy to promote current economic growth could lead to a buildup of vulnerabilities that increases the variance of output or downside risks to output in the future. This formulation emphasizes that considering risks to financial stability is

[10]For example, in a financial crisis, the positive impact of looser policy on risk-taking can improve financial stability.

not inconsistent with the mandates of price stability and maximum employment.

Of course, the consideration of both financial conditions and financial stability in the conduct of monetary policy is not without possible costs. Conceptually, incentive problems between price stability and financial stability could arise if clear priorities are not set (Smets 2013). For example, ex post monetary policy easing in a credit bust to inflate away some of the debt overhang could generate an inflation bias. If there are political pressures to not lean too hard against the wind, or to not engage in sectoral credit allocation, central bank policymakers with responsibilities also for financial stability may have incentives to use monetary policy ex post, which can then risk price stability.

Several papers model the interaction of both macroprudential and monetary policy. In Farhi and Tirole (2009, 2012), financial intermediaries make private choices about leverage and maturity transformation, taking into account anticipated monetary policy responses. Loose interest rate policies increase the likelihood of future crises because they provide incentives for greater maturity mismatch because central banks ex ante cannot commit not to inject liquidity after a crash, leading to excessive risk-taking in the aggregate. Farhi and Tirole (2012) argue that preemptive macroprudential policies, such as limits on short-term debt or restrictions against hoarding liquidity at financial firms, would increase welfare, to offset incentives of firms to correlate their risks.

Korinek and Simsek (2016) consider the relative efficiency of macroprudential and monetary policies in a setting where borrowers do not take the negative aggregate demand externality of leverage into account, resulting in excessive risk-taking. Monetary policy is constrained at the zero lower bound, giving rise to a shortfall in aggregate demand. An interesting result of their model is that debt limits (or mandatory insurance) can improve welfare, while a rise in rates to reduce leverage could prompt a recession, and borrowers may want to borrow even more to smooth consumption. In addition, a rise in rates transfers wealth from borrowers to savers, providing another incentive to borrow. Thus, macroprudential policies are more efficient than monetary policies for reducing excessive leverage. Efficiency requires setting a wedge between borrowers' and lenders' relative incentives to hold bonds, whereas interest rate policies

create a different intertemporal wedge that affects all incentives equally.

Several models focus on the coordination of macroprudential and monetary policies. Angelini, Neri, and Panetta (2012) show that the benefits of coordinated policies are sizable for financial shocks, but macroprudential policies may add to volatility in the case of typical real supply shocks if they are not coordinated with monetary policy. Angeloni and Faia (2013) show that a combination of countercyclical capital and monetary policy to a positive productivity shock that leads to bank leverage can be welfare enhancing (see also Christensen, Meh, and Moran 2011). Kiley and Sim (2015), in a model with financial intermediaries and asset prices, find that monetary policy acting according to a simple rule reacting to financial imbalances may not improve welfare, and will depend on the source of the shock, which is difficult for policymakers to identify in real time. For example, tighter policy to respond to shocks at financial intermediaries might enhance welfare, but monetary policy to offset a rise in credit-to-GDP because of a positive technology shock would not. The combination of macroprudential and monetary policy can generally improve welfare in their setting.

In addition, monetary policy tightening can put financial institutions closer to default, resulting in risk-shifting incentives, leading them to take on more, not less risk. A theoretical setting that studies this risk-shifting effect is presented by Dell'Ariccia and Marquez (2013) and Dell'Ariccia, Laeven, and Marquez (2014).

While risk-shifting is theoretically possible in that setting, it is usually dominated by the first-order effect which links rising rates to lower risk-taking, when capital constraints are not binding. However, Landier, Sraer, and Thesmar (2011) investigate the lending behavior of New Century Financial Corporation, a large subprime lender in the run-up to the 2007–09 crisis, and find evidence of risk-shifting. As the Federal Reserve began tightening rates in 2004, the increase in rates led to a large, adverse shock in the value of the loan portfolio that New Century held for investment purposes. New Century reacted to this loss to the value of its assets by lowering underwriting standards and issuing deferred amortization mortgages. These loans were riskier and more sensitive to housing valuations, substantially increasing risk-taking. New Century's shareholders thus gambled for resurrection, as their equity value was

low, and their risk-taking incentives (due to limited liability) were large.

In summary, there is an expanding literature to address the question of whether and how monetary policy should consider financial stability. These models include financial frictions such as asymmetric information, which lead to effects of asset prices on collateral values and borrowing constraints, institutional investor sticky nominal return targets, financial firms' risk models and limited liability, and agency costs. Moreover, individual borrowers do not have incentives to take into account their effects on aggregate debt when they make their own private decisions. Such financial frictions can lead to a buildup of vulnerabilities and a more fragile financial system in the future that is more prone to amplify negative shocks and end badly for the economy. At the same time, there are costs to using monetary policy for financial stability. For example, consideration of financial stability could lead to an inflation bias, moral hazard, and welfare reductions because tighter policy is too late to stop a credit boom or it tries to stamp out credit growth that reflects technology gains rather than excessive borrowing. More research is needed, but there is considerable evidence to suggest that models for the conduct of monetary policy need to incorporate more financial-sector features—in particular, time-varying risk premia and risk-taking.

6. Cost-Benefit Analysis of Using Monetary Policy to Lean Against the Wind

We use Svensson's (2016) framework, which builds on Svensson (2014), to illustrate how adding the risk-taking channel of monetary policy through asset prices and borrower leverage could significantly change a cost-benefit calculation for the use of monetary policy to lean against the wind (LATW). Svensson has posted a spreadsheet for his cost-benefit analysis in a simplified two-state example and has invited alternative assumptions, though his own extensive sensitivity analysis based on a multi-period model is that none appear to overturn his conclusion that the costs of LATW policy exceed the benefits.[11] We use the two-state example since our primary

[11]Svensson's spreadsheet is available at http://larseosvensson.se/files/papers/svensson-simple-example-of-cost-benefit-analysis-of-leaning-against-the-wind-v3x.xlsx. Note that the key assumptions in the spreadsheet that Svensson

aim is to highlight some key assumptions for the net cost calculation and to suggest that more research is needed on the estimated parameters.

The spreadsheet analysis is collapsed to two states—crisis and non-crisis. The analysis is to compute the costs and benefits of a LATW policy, defined as raising interest rates by 1 percent for four quarters, and compare the welfare costs of LATW unemployment outcomes with unemployment outcomes of an initial baseline path (when the unemployment gap is assumed to start at zero).[12] In this framework, LATW monetary policy works through traditional mechanisms by reducing credit and increasing unemployment. There are no asset prices or lender or borrower behavior in the model, so a higher monetary policy path does not raise risk premiums or rein in risk-taking. Consequently, LATW does not reduce the severity of a subsequent crisis—the size of the unemployment increase in the crisis state—and it reduces the probability of a crisis by only a minimal amount in his model.

In Svensson's analysis, the benefits of LATW are to reduce credit and then the probability of a crisis. He estimates that raising the policy rate (i) by 1 percentage point for four quarters leads to a decline in household credit, a maximum of 1 percent (as estimated from the Riksbank model). Because monetary policy is neutral in the long run with respect to credit, the level of credit rises back to baseline by the end of the forty quarters, with credit growth peaking at around sixteen quarters. Lagged two-year credit growth then is used to determine the probability of a crisis using estimates from Schularick and Taylor (2012). Based on peak credit growth, the probability of a crisis start is about 3 percent; and assuming the economy stays in a crisis for eight quarters, the probability of being in a crisis (p)

provides and that are used for these figures, in which he collapses the model to two states, will not capture the variation over time in the probability of a crisis. But in this model, credit is neutral with respect to monetary policy, so high growth rates are offset by low growth rates, suggesting that the probability of a crisis relative to baseline can be negative and offset by positives. The spreadsheet uses parameters from periods when it is possible for policy to reduce a probability of a crisis relative to baseline.

[12]Note that the terminology is crisis and non-crisis, but the model does not have a financial sector, so the two states could also be called recession and non-recession.

is 6 percent. The effect of a higher policy rate on the probability of a crisis (dp/di) is estimated to be –0.1 percent. That is, a higher policy rate i of 1 percentage point would reduce the probability of a crisis from 6.0 percent to 5.9 percent.

In terms of the costs of LATW, raising i by 1 percentage point leads to an increase in the unemployment rate ($dU_{L,N}$) in the non-crisis state by 0.5 percent (line 2 of table 4), relative to a change of 0 in the baseline ($dU_{B,N}$), line 1, where $dU_{i,j}$ is the increase in the unemployment rate where i = L for LATW or B for baseline, and j = C in the crisis state or N in the non-crisis state. The model assumes that the increase in the unemployment rate once a crisis occurs is 5 percent, regardless of whether or not policymakers choose LATW ($dU_{B,C} = dU_{L,C} = 5$ percent, lines 1 and 2). This assumption is critical: Policymakers receive no payoff in the form of a smaller rise in unemployment in a future crisis from choosing LATW policy. Below we illustrate the sensitivity of the expected cost and benefit estimates to alternative assumptions for the size of the unemployment increase in a future crisis state.

The expected welfare cost of LATW policy assuming that ($dU_{B,C} = dU_{L,C} = 5$) (shown in line 7) is the probability-weighted welfare cost from higher unemployment in a non-crisis state and higher unemployment in the crisis state. More generally, the expected welfare cost can be graphed as a function of alternative values of $dU_{L,C}$, the increase in unemployment under LATW policy in the crisis state relative to $dU_{B,C} = 5$. Specifically, point C on the expected cost line in figure 2 refers to welfare costs of 0.55 in the initial case.

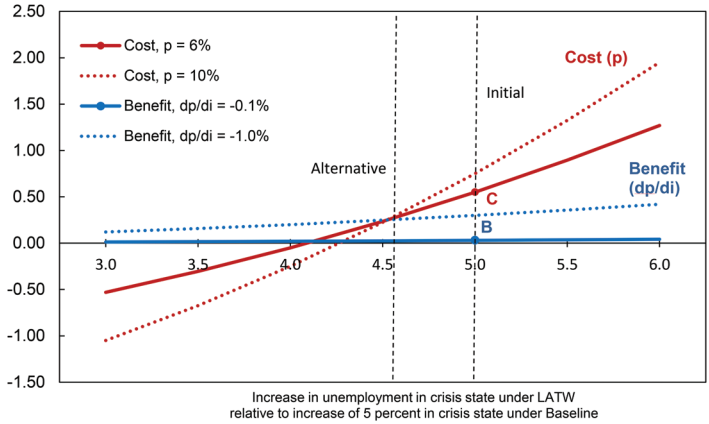
The expected benefit of LATW policy is also plotted, and point B (line 8 in the table) represents the initial case ($dU_{B,C} = dU_{L,C} = 5$). In this initial case, the expected benefits of .03 are considerably lower than the expected costs. With the parameters of the initial case, the increase in unemployment in the crisis under LATW would need to be 4.1 percent, about 0.9 percent lower than the assumed 5 percent, for the expected benefits of LATW to equal the expected costs.

Below we provide sensitivity analysis for three critical assumptions: (i) the rise in unemployment in a crisis; (ii) the probability of a crisis; and (iii) the elasticity of the probability with respect to a change in the policy rate.

Table 4. Estimated Costs and Benefits of LATW Policy in Svensson (2016) when the Unemployment Increase in a Future Crisis Is 5 Percent for Baseline and LATW

	Non-crisis State	**Future Crisis State**
(1) Baseline Unemployment (ppt)	$dU_{B,N} = 0$ $U_{B,N} = 0.0$	$dU_{B,C} = 5$ $U_{B,C} = dU_{B,N} + dU_{B,C} = 5.0$
(2) LATW Unemployment (ppt)	$dU_{L,N} = 0.5$ $U_{L,N} = 0.5$	$dU_{L,C} = 5$ $U_{LC} = dU_{L,N} + dU_{L,C} = 5.5$
(3) Baseline Welfare Cost ($U^2_{B,j}$)	0	25
(4) LATW Welfare Cost ($U^2_{L,j}$)	.25	30.25
(5) LATW Welfare Cost Increase Relative to Baseline (Line 4 – Line 3)	.25	5.25
(6) Probability-Weighted Cost (for $p = .06$)	$(1-p) * .25 = .235$	$p * 5.25 = .315$
(7) LATW Expected Cost	$[(1-p) * (U^2_{LN} - U^2_{BN}) + p * (U^2_{LC} - U^2_{B,C})]$ $= .235 + .315$ $= .55$	
(8) LATW Expected Benefit	$= -(dp/di) * [U^2_{L,C} - U^2_{LN}]$ $= -(-.001) * [30.25 - .25]$ $= .03$	

Figure 2. Welfare Costs and Benefits of LATW for Alternative Values of Unemployment Increase in a Future Crisis Relative to an Increase of 5 Percent in Baseline



6.1 Increase in Unemployment

Svensson assumes that the rise in unemployment even after LATW policy is still 5 percent. If we were to assume instead that LATW policy reduces credit and the severity of the crisis when it occurred, then costs of LATW policy would be lower. For example, as shown by the cost line (for $p = 6\%$ in baseline), if $\mathrm{dU}_{L,C}$ is 4.5 percent (less than $\mathrm{dU}_{B,C} = 5\%$), the costs of LATW policy would be .23, roughly half the costs when $\mathrm{dU}_{L,C}$ is 5 percent. If the assumed rise were even smaller, if $\mathrm{dU}_{L,C}$ were 4.0 percent, the costs of LATW policy would be negative, and net benefits would be positive. That is, the costs of LATW policy decrease substantially if the policy were to lead to reductions in the size of the increase in unemployment in a future crisis.

Benefits also vary positively with the increase in $\mathrm{dU}_{L,C}$, but the slope is very small, reflecting the estimate that a rise in policy rate barely reduces the probability of a crisis. A smaller rise in unemployment in a crisis from LATW policy (4.5 percent rather than 5 percent) would reduce the benefits of LATW policy, but only by a little.

Svensson cites Flodén (2014) as an estimate of the effect of higher debt on the rise in unemployment. A 1 percentage point higher household debt-to-income ratio in 2007 results in an increase in unemployment during 2007–12 of 0.02 percentage point (indicating a decline of dU_C from 5 percent to 4.98 percent), a very small effect. Other empirical studies provide strong evidence that higher credit growth results in more severe recessions, suggesting that a smaller increase in unemployment from LATW policy is an alternative reasonable assumption. Unfortunately, most other studies have focused on the effects of credit growth rather than the level of credit on the severity of a recession, or the effect on output rather than unemployment. Flodén (2014) also looks at both the level and growth of credit, and finds they are both significant in explaining a subsequent decline in output, though only the level is a significant factor in the unemployment rate regression.

Jordà, Schularick, and Taylor (2013), in a study of fourteen countries with data starting in some cases in 1870, provide evidence that more excess credit growth in the period preceding a recession (relative to growth of the previous expansion) substantially increases the adversity of the subsequent recession, for both normal recessions and financial recessions (those with substantial losses to the banking sector). Their estimates show, for example, that in a normal recession, by the fourth year after the cyclical peak, the economy would be well into a recovery, with real GDP per capita estimated to be 3.8 percentage points higher than the cyclical peak. In the case of a financial recession, however, the economy would still not have fully recovered, with the GDP per capita level at –2.8 percentage points below the cyclical peak for average pre-recession excess credit growth. The strength of the recovery also depends on excess credit: in a normal recession, had credit exceeded average levels by one standard deviation, real GDP per capita would be lower by 1.8 percentage points, at 2.0 percent, and in a financial recession, real GDP per capita would be lower by 3 percentage points, at –5.8 percent, in the fourth year after the peak. While these estimates suggest significant effects for excess credit on lost output in the subsequent recession, it is difficult to convert their estimates to the effects of a 1 percentage point rise in the level of credit, given their measure of excess credit.

Mian, Sufi, and Verner (2015) also show that a steeper rise in household debt-to-GDP predicts higher unemployment and lower output over the medium term, based on data for thirty-four countries from 1960 to 2012. Specifically, they document that a one-standard-deviation increase in household debt-to-GDP growth in the three years before a cyclical peak leads to a 0.82 percent increase in the unemployment rate in the subsequent three years (and a decline in GDP growth of –2.1 percent). Their estimates imply that a 1 percentage point increase in credit growth in the three years before a cyclical peak would lead to a rise in unemployment of .13 percentage points and a decline in output of –.37 percentage points.

Sutherland et al. (2012) examine a sample of OECD countries from 1950 to 2010 and document that recessions occur twice as often and output declines during the recession are larger for high-debt versus low-debt levels (based on detrended debt to potential GDP). They also document that high debt levels lead to substantially greater volatility in output and consumption, and suggest that average effects miss an important cost dimension for households that are risk averse.

More recently, Gourio, Kashyap, and Sim (2016) model a tradeoff of LATW policy in a new Keynesian DSGE model. Their model highlights, as does Svensson (2016), that a tradeoff exists for a LATW policy relative to a policy based only on the output gap. They show that reduced credit comes at the expense of higher volatility in output and inflation, and then also highlight under what conditions welfare would be higher with a LATW policy despite the higher volatility. An interesting result is that if crises lead to permanent losses in output, which they argue are substantial, rather than just temporary losses associated with more typical business cycles, the benefits of LATW are greater. Their estimates of the severity of crises are measured as the gap between actual output and potential output at the onset of each crisis. They show that for the United States in the most recent crisis, this cost is 10 percent of output, despite the fact that the unemployment rate has almost returned to its natural rate.

While the research is growing, much more research is needed for robust estimates of the linkages from monetary policy to household and business credit, and then the effects of credit on the severity of a subsequent recession. Studies usefully have different samples,

but some focus on credit levels and others on credit growth, and what is viewed as average sustainable credit growth differs across the studies. What is clear is that debt levels in some expansions can become very high and the subsequent contractions can be more severe. But the differences in studies makes it difficult to settle on a single reliable estimate of the elasticity of unemployment or output to a change in credit.

Furthermore, broader financial conditions might be important conditioning variables for the severity of crises and hence for monetary policy. For example, Adrian, Boyarchenko, and Giannone (2016) show that the conditional GDP distribution depends significantly on financial conditions such as credit spreads, term spreads, and market volatility. In particular, such variables forecast sharp movements in the downside risks to GDP growth which should be taken into account in setting monetary policy even under flexible inflation targeting. Aikman et al. (2016) find that the non-financial credit-to-GDP gap is an important conditioning variable for economic activity, since the effects of financial conditions and monetary policy vary with the credit gap. Monetary policy is less effective when the credit gap is high, consistent with it being harder to stop a credit boom once one is under way and with a more muted transmission of the short-term policy rate to distant forward rates, in the spirit of Hanson and Stein (2015), who link the transmission of reductions in short-term policy rates to declines in forward rates and term premiums to the behavior of reach-for-yield investors.

6.2 Probability of Crisis

Another important parameter for the expected cost of LATW policy is the probability of a crisis. The estimations based on the sensitivity of household credit to interest rates in Sweden imply a probability of crisis start of 3 percent, about once every thirty years, and probability of being in a crisis of 6 percent (assuming weak growth for two years). In the United States, since 1975 there have been five recession starts (one in eight years), in which two (1990 and 2008) involved significant financial-sector stress.[13] Based on these estimates of a

[13]The banking crisis that started in 1988 and includes the 1990 recession has also been labeled a financial crisis by Laeven and Valencia (2008). More than

crisis start of 5 percent, it is reasonable to evaluate the sensitivity of the costs of LATW policy if the probability of being in a crisis were 10 percent.

In figure 2, we show the expected cost curve if the probability of being in a crisis is 10 percent rather than 6 percent. The slope of the cost curve steepens significantly as a function of the crisis probability, and the costs of LATW policy fall below the benefits at around 4.3 percent, a less modest reduction in unemployment severity from LATW policy. That is, if the rise in unemployment were 4.3 percent, the costs of LATW policy become less than the benefits.

6.3 Elasticity of Crisis Probability

Given the very small benefits and the relative flatness to changes in assumed increases in unemployment in a crisis under LATW policy, we also explore the sensitivity of benefits to an increase in the elasticity of the probability of a crisis to a change in the interest rate. The proposed estimate of –0.1 is small (would reduce the probability from 6 percent to 5.9 percent). The current literature does not provide much guidance for alternative estimates of this elasticity. In fact, changes in credit growth from a change in monetary policy are typically evaluated in models that do not consider time-varying pricing of risk or endogenous risk-taking by financial intermediaries, and likely underestimate the sensitive of credit to monetary policy. We assume alternatives for the purpose of illustrating the sensitivity of the estimated benefits. For example, if $dp/di = -1$ for $p = 10\%$ (the light-gray dotted line, figure 2),[14] the benefits of LATW are notably larger. For this parameter, if we assume again that the rise in unemployment under LATW policy is 4.5 percent, the benefits of LATW policy exceed the costs. Indeed, with this higher elasticity, LATW policy starts to yield positive net benefits when $\mathrm{dU}_{LC} = 4.6\%$, shown by the vertical line labeled "Alternative." That is, under alternative assumptions for the probability of a crisis and its sensitivity to a rise in the monetary policy rate, even a very small benefit in terms

1,400 savings and loans and 1,300 commercial banks failed during 1988–92, and the cost to the government amounted to $180 billion, more than 3 percent of GDP.

[14]This line is shown as light blue in the online version, available at http://www.ijcb.org.

of a smaller rise in unemployment from LATW policy (a rise of 4.6 percent rather than 5.0 percent) would suggest that LATW policy has net benefits.

6.4 The Risk-Taking Channel in the Cost-Benefit Analysis

These observations support more testing of the sensitivity of the cost-benefit calculations to other estimates for the probability of crises and its sensitivity to monetary policy. The emerging research reviewed above suggests that models that do not incorporate the effects of monetary policy on endogenous risk-taking of borrowers or financial institutions would likely lead to an understatement of the sensitivity of probability of a crisis and the severity of a recession to monetary policy.

6.5 Implications of the Cost-Benefit Analysis

To summarize the sensitivity analysis, the result that costs exceed benefits relies critically on assumptions about the change in unemployment in a crisis, the crisis probability, and the elasticity of crisis probability with respect to the interest rate. For example, as illustrated by the calculations above, if the rise in unemployment in a crisis following a LATW policy was even just 4.6 percent rather than 5 percent, the conclusion that the costs of LATW policy would exceed the benefits would not hold. More research is needed to pinpoint the parameters for this cost-benefit calculation before applying the initial conclusion.

Of course, even if credit growth or risk-taking were amplifiers, it does not mean necessarily that monetary policy should target credit or risk-taking. Alternative tools, such as LTVs, DTIs, and bank capital, may be better suited to reduce excess credit because it can be more targeted. But in a complex advanced financial system with banks and non-bank financial intermediation, macroprudential policy may not be effective, because restrictions on regulated firms may push the activities into the unregulated sector.

7. Conclusion

The stance of monetary policy is transmitted to the real economy via multiple channels. In asset markets, the pure expectations channel is

complemented by a risk-taking channel, reflected by changes in the pricing of risk. These changes in the price of risk can be evident in asset markets, the banking sector, shadow banking, and non-financial-sector borrowers. As financial intermediation has become increasingly market based, the risk-taking channel has become more important, particularly in the shadow banking system, which relies principally on asset prices to support short-term funding. Risk-taking associated with expansionary monetary policy can cause the buildup of vulnerabilities that can generate systemic financial crises when adverse shocks hit.

Even if monetary policy were to contribute to the buildup of vulnerabilities—as both theory and empirics support—it does not mean that monetary policy should target these vulnerabilities. Most view macroprudential policies as the first-order defense against such buildups of vulnerabilities. However, macroprudential policies only directly affect a limited set of financial institutions due to shadow banking, have limited international reach, and are potentially subject to long implementation lags. Monetary policy, on the other hand, affects funding conditions for all intermediaries, more immediately, and has some global reach. Cost-benefit analysis of the use of monetary policy that does not incorporate the role of asset prices and credit may not be robust. While these arguments may lead to a conclusion that is uncomfortable because of the higher burden on monetary policy, cleaning up after the bust has proven in the long wake of the Great Financial Crisis to be extremely costly. More research is needed to evaluate the efficacy of macroprudential and monetary policies, independently and jointly, to prevent the buildup of vulnerabilities and to mitigate the consequences of busts on the real economy.

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