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Unstable banking ☆

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A B S T R A C T

We propose a theory of financial intermediaries operating in markets influenced by investor sentiment. In our model, banks make, securitize, distribute, and trade loans, or they hold cash. They also borrow money, using their security holdings as collateral. Banks maximize profits, and there are no conflicts of interest between bank shareholders and creditors. The theory predicts that bank credit and real investment will be volatile when market prices of loans are volatile, but it also points to the instability of banks, especially leveraged banks, participating in markets. Profit-maximizing behavior by banks creates systemic risk.

1. Introduction

Traditional theories of financial intermediation describe banks as accepting deposits, primarily from households, and making loans, primarily to firms (Diamond and Dybvig, 1983; Diamond, 1984; Gorton and Winton, 2003). Yet large modern banks also participate in financial markets by originating and distributing securities, trading, and borrowing money. The involvement of banks in markets requires a revision of the theory of financial intermediation.[1] In particular, this involvement raises the central question of how banks allocate their limited capital among competing activities, such as direct lending and market trading. It also raises the question of how banks, as they participate in both traditional intermediation and in markets, affect real economic activity.

We propose a theory of financial intermediaries operating in markets influenced by investor sentiment. Sentiment can reflect either biased expectations or institutional preferences and constraints, such as the demand by foreigners or money market funds for AAA-rated securities. In our model, banks make, securitize, distribute, and trade loans, or they hold cash. They also borrow money, using their security holdings as collateral. We embed such banks in a financial market in which securitized loans can be mispriced, and examine how banks allocate limited capital among various activities, as

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[1] Gorton and Pennacchi (1995) and Allen and Gale (1997) are important early models of banks operating in markets. Our focus is very different from theirs.

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well as how they choose their capital structure. Banks maximize profits, and there are no conflicts of interest between bank shareholders and creditors. The theory predicts that bank credit and real investment will be volatile when market prices of loans are volatile, but it also points to the instability of banks, especially leveraged banks, participating in markets. Profit-maximizing behavior by banks creates systemic risk.

In this model, when banks participate in financial markets, they cater to investor sentiment. Banks use their scarce capital to co-invest in newly securitized loans when asset prices are high, and to buy or hold on to distressed securities when asset prices are low. Expanding the balance sheet to securitize is so profitable in good times, however, that banks borrow short term and accept the risk of having to liquidate their portfolio holdings at below fundamental values in bad times. Such asset fire sales further destabilize security prices. By stretching their balance sheets to the limit in good times, banks give up the opportunity to finance investment or buy distressed assets in bad times.

Under these circumstances, bank profits and balance sheets, as well as real investment, are highly cyclical. Investment is strictly higher with securitization than without it, but can be distorted in favor of projects available for securitization during bubbles. This can reduce efficiency even without any costs of cyclical fluctuations. The central message is that financial intermediation transmits security market fluctuations into the real economy; the volatility of sentiment turns into the volatility of real activity.

Our paper is related to three broad strands of research, including work on the microfoundations of credit cyclicality; research on asset liquidity, fire sales, and limited arbitrage; and work in behavioral corporate finance. We attempt to unify these three strands by describing how banks transmit market fluctuations into the real economy.

The literature on the microfoundations of credit cycles primarily focuses on the magnification of shocks to the value of capital and their impact on credit through collateral and incentive compatibility constraints.[2] This approach is taken in Bernanke and Blinder (1988), Holmstrom and Tirole (1997), and Kiyotaki and Moore (1997). Shleifer and Vishny (1992) show how asset liquidity, high debt capacity, and easy credit are mutually reinforcing. Adrian and Shin (2009) document the procyclicality of leverage using data on broker–dealers. Allen and Gale (2000) model an asset market bubble fueled by unexpectedly loose monetary policy. Unlike this literature, our paper focuses on the allocation of scarce bank capital among competing activities over time, and the implications for the cyclicality of real activity.

Adrian and Shin (2008) put forward a theory of procyclical leverage and credit availability based on the optimizing behavior of financial intermediaries. In their model, procyclical leverage comes from the focus of investment banks on value at risk. Adrian and Shin argue that volatility is countercyclical, allowing banks to take more leveraged bets when asset prices are high. Rajan (2006) stresses the role of agency problems, distorted compensation structures, and the difficulty of understanding the riskiness of complex financial instruments in generating procyclical risk-taking. Unlike Adrian and Shin (2008) and Rajan (2006), we do not focus on the banks' incentives for risk-taking, but rather address the ways that banks can profit from changes in investor sentiment and their consequences for capital allocation over time.

Our paper is also related to the literature on asset liquidity, fire sales, and limited arbitrage. Shleifer and Vishny (1992) show how asset illiquidity, defined as the inability to sell an asset for its value in best use, results from the simultaneous debt overhang facing all of the specialist buyers in a given industry. Shleifer and Vishny (1997) show how asset prices fall below fundamental values when intermediaries involved in arbitrage lose the capital of uninformed investors after poor performance. Arbitrageurs liquidate their positions in a crisis, rather than stabilize prices. Recently, research in this area has advanced rapidly, with significant contributions by Gromb and Vayanos (2002), Fostel and Geanakoplos (2008), He and Krishnamurthy (2008), Acharya, Gale and Yorulmazer (2009), Benmelech and Bergman (2009), Brunnermeier and Pedersen (2009), and Diamond and Rajan (2009).

Finally, our paper is related to the extensive literature on behavioral corporate finance. Baker and Wurgler (2002, 2004) show how firms cater to investor sentiment through their dividend and capital structure policies. We use related ideas to understand the behavior of banks. Of particular relevance in this literature is the relationship between the mispricing of assets and the real investment by firms (Stein, 1996).

In reviewing this research, we have not uncovered any work that focuses on the specific role played by banks in transmitting fluctuations in investor sentiment into the real economy. Likewise, we have not found much analysis of how market conditions shape the allocation of scarce bank capital across lending and proprietary trading, or how they influence the banks' own financing decisions.

In Section 2, we present our model. Section 3 considers the case in which banks cannot borrow but can participate in financial markets by securitizing loans. Many of our central results emerge in this simplified case. Section 4 examines what happens when banks can borrow and further expand their balance sheets when they face good opportunities. Many of our findings on instability become more extreme. Section 5 focuses on the endogenous determination of security prices. It shows that bank instability is closely associated with financial market instability, and that the two reinforce each other. Section 6 brings the findings together by considering the possible relevance of our results for the current financial crisis, as well as for appropriate policy interventions.

2. The model

We consider a model with three periods: 1, 2, and 3. The model is highly stylized in that we do not derive

[2] An older literature on cyclical credit includes Fisher (1933) and Minsky (1986). The foundational work on optimal debt contracts, first written in 1989, is Hart and Moore (1998).

optimal financial contracts. Instead, we rely on previous work to assume a reduced-form version of these contracts. We then investigate the consequences of such contracts for market equilibrium. For stark focus, we examine the model with no fundamental risk to investment and a risk-free interest rate of zero.

2.1. Projects

Real activity in the model consists of projects that become available in periods 1 and 2 and that all pay off in period 3. Each project costs \$1 to undertake. Through most of the paper, we consider identical projects. When started at t=1, these projects pay a known amount $Z>1$ in t=3 for certain. When started at t=2, these projects pay the same known amount Z in the same t=3 for certain.[3] Period 1 projects are long term and do not pay off until time 3. The supply of projects costing \$1 and yielding $Z>1$ is infinite, so their realization is constrained only by finance.

Screening or monitoring by an informed intermediary is required to separate these projects from the bad ones with $Z<1$. All projects must therefore be financed by banks.[4] When a bank finances a \$1 project, it collects an up-front fee f from the entrepreneur and a certain repayment of \$1 at t=3. We assume that the entrepreneur and the bank split the surplus from the project, so $f = \alpha \cdot (Z-1)$ with $0 \le \alpha \le 1$ depending on the competitiveness of the banking sector. For simplicity, we assume that the entrepreneur pays the fee from his personal funds.

We occasionally consider the case in which, at both times 1 and 2, the projects are not all identical. Instead, there are high (H) and low (L) projects that all cost the same \$1 but pay off Z_H and Z_L with $Z_L<Z_H$ and $f_L<f_H$. We assume that the number of high projects is limited to N_H each period but the supply of low projects is infinite.

2.2. Banks

All financing in the model is done by banks. The representative bank comes into period 1 with E_0 in equity. We do not consider deposits, or bank runs by depositors as in Diamond and Dybvig (1983), although these could be added. Let N_t be the number of new projects the bank finances at time t, with t=1, 2. Let E_t be the bank's equity at the end of time t=1, 2, 3, where E_0 is equity at the very start.

The bank can use its resources in several ways. First, it can hold cash. We denote by C the amount of cash it holds at the end of period 1. Under our assumptions, the bank never chooses to hold cash at time 2 because there are no opportunities arising at time 3. The bank can also purchase securities, as we discuss below. Finally, it can lend money for projects, in which case it collects the fee up front and receives the repayment of \$1 for certain at time 3, since projects are assumed to be riskless and the interest rate is zero.

The bank can do one of two things with these project loans. It can keep them on its books, which we refer to as traditional lending (origination). Alternatively, the bank can securitize these loans and sell them in the financial market (distribution). We do not allow banks to securitize commitments to make future loans.

We model securitization as simply the sale in the market of cash flow claims that would otherwise be held by banks. We do not model packaging and tranching of loans, so in our model securitization looks a lot like loan syndication. We simply assume that each individual loan to a firm can be sold in the market and represents a claim to \$1 for certain at time 3. In our model, all loans are the same. Packaging and tranching would amplify the effects we model if they cater to investor demand and thereby improve the terms on which banks can sell securities or borrow against them (because, for example, engineered securities are rated AAA).[5] Such securitization would allow the bank to more profitably expand its balance sheet in response to market conditions.

Our central assumption about securitization is that when the bank sells a loan in the market it must initially keep a fraction d of the loan on its own books. We can think of d as the bank's necessary initial "skin in the game" when it securitizes loans. If N projects are financed and the corresponding loans are securitized, the bank must hold dN of these securities on its balance sheet at the time of the underwriting. We assume that the bank does not need to hold on to these securities for more than one period.

We do not derive d from first principles, but a large literature justifies this assumption. In Gorton and Pennacchi (1995), incentive-compatible contracts for loan sales involve the bank retaining a portion of the loan or else guaranteeing the loan against default. They find empirically that in loan sales, the most common arrangement is for the bank to retain a portion of the loan, which is greater for riskier categories of loans.[6] More complex implicit contractual arrangements are also common, as discussed by Gorton and Souleles (2006) for credit card securitizations and by Brunnermeier (2009) for liquidity backstops provided by sponsors of structured investment vehicles (SIVs). Our d can serve as a summary measure of these arrangements. Empirically, the required skin in the game can be lower when asset prices are high, possibly because investors are less cautious about information asymmetries and agency problems when they are optimistic. This alternative assumption would only strengthen our results.

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[3] The reason to have both periods 1 and 2 projects pay off in period 3 is to avoid having period 4.

[4] Unlike Fama (1985), we assume that banks are special and that firms cannot obtain finance directly from markets. For a summary of considerable evidence on this point, see Gorton and Winton (2003).

[5] In our model, one role of the banks is to identify asset classes with abnormally high demand from investors and then structure the loans to borrowers and the securitized cash flow claims on those loans to cater to investor demand. Banks can still have a monitoring function, as in Diamond (1984).

[6] Sufi (2007) provides corroborative evidence for the assumption about skin in the game using data from the syndicated loan market. Holmstrom and Tirole (1997) show that, in an optimal contract, a bank that needs incentives to monitor borrowers co-invests with outsiders in making loans.

When the bank securitizes a loan, it can sell the securities it does not retain in the market. We denote by P_t with t=1, 2 the price of the securities at time t. In the case of identical projects, all securities are obviously identical. Even with heterogeneous projects, we can assume that security prices are all identical, since each security corresponds to a loan of $1 that pays off $1 for sure at time 3, regardless of the project.

Prices of securitized debt can deviate from the rational price of 1 because of investor sentiment. We assume that sentiment affects all securitized debt by the same amount, but do not consider inefficiencies in other markets such as bank stocks. Although sentiment here affects one particular asset class (securitized debt), it can come from a variety of sources, such as shifts in psychology, regulatory rules, or demand for a particular asset class that is otherwise unrelated to fundamental payoffs. For example, if some investors such as foreigners, insurance companies, or money market funds demand AAA-rated bonds for reasons beyond the fundamental economics of payoffs, and are willing to pay substantially more for such bonds than for almost equally safe bonds, we think of this as investor sentiment (Caballero and Krishnamurthy, 2009; Gorton and Metrick, 2009). Such demand can be fueled by loose monetary policy, which lowers risk-free rates and can cause investors seeking yields to overpay for higher-yielding securities still perceived to be safe. Demand can also be boosted by evidence of a favorable recent default history, as when Drexel sold large amounts of high-yield corporate bonds in the LBO boom of the 1980s (Kaplan and Stein, 1993) or when the price appreciation of houses made mortgage defaults relatively rare. At the other end of the spectrum, bad fundamental news can cause investors to dump securities when they lose confidence in their valuation models (Caballero and Krishnamurthy, 2008).

Until Section 5, we take security prices as exogenous, on the assumption that arbitrage is limited and does not drive those prices to the fundamental value of 1 (De Long, Shleifer, Summers and Waldmann,1990; Shleifer and Vishny, 1997). For simplicity, we focus on the case in which $P_2 < P_1$ (and in particular $P_1 > 1$ and $P_2 < 1$) and the bank actually knows P_2. We are thus looking for conditions under which the bank expands its balance sheet at time 1 even when it knows that good times are about to end. We assume that the bank understands the model, including the fact that the fundamental value of securities is 1 at all times (recall that the interest rate is zero).

The assumption that the bank knows P_2 makes it *harder* to have an equilibrium in which the bank allocates all its resources at time 1 to securitization, especially with leverage. If the bank believes that there is some chance that the bubble will continue, it has a stronger incentive to expand its balance sheet because it knows that, should security prices stay high, it can sell its portfolio at a profit and originate and distribute even more loans next period.[7]

[7] Recall that the bank is only required to hold its skin in the game on securitized loans for one period. If the bank must hold its skin in the game until time 3 and expects further appreciation of security prices, it might want to hold cash until time 2 to securitize at even higher prices.

The belief that prices are about to fall only reduces the attractiveness of securitization because the bank expects losses on its holdings and also forgoes an opportunity to wait and invest in distressed securities. A bank uncertain about future prices is thus more likely to securitize all it can than a bank that fully anticipates the price decline. Our results are not driven by the assumption of perfect foresight or the bank's belief that the ability to securitize is only temporary. Securitizing the maximum possible amount is always attractive as long as prices are high and are not expected to fall too much. One can think of the perfect-foresight equilibrium as providing conditions on P_2 and the other parameters under which banks fully extend themselves despite recognizing the likelihood that the bubble will burst.

The bank has an incentive to securitize loans only if $f > 1 - P_1$, since it needs to supply $1 to the entrepreneur. To simplify matters, we assume that when the bank sells loans at a price $P_1 > 1$, it collects profits $(P_1 - 1)(1 - d)$ per loan from security buyers and immediately distributes these profits, as well as the fees obtained from the entrepreneurs, as dividends or employee compensation.

This is a strong assumption, since retaining profits would enable the bank to buy underpriced securities, or avoid liquidation, at time 2. Nonetheless, we think it is appropriate. First, competitive pressures, in particular those for retaining key employees, might force the banks to distribute a large share of profits as compensation. Second, if the bank retains profits, its profit-maximizing policy, as we show below, is not to keep them in cash but instead to instantaneously recycle profits to finance and securitize additional projects. For tractability, we do not allow for such recycling of profits within a period. The key point is that profit-maximizing banks do not retain profits as a safety cushion in our model, which contributes to instability.

Just as the bank can profitably underwrite and sell securities when prices are at least equal to 1, the bank that has capital can buy securities. We are interested in the case in which $P_2 < 1$, so that it might be in the interest of the bank to buy securities at t=2 that pay off $1 at t=3. We also need to consider, for this reason, the question of whether the bank wants to hoard cash at time 1 so as to be able to buy securities in distressed markets.

The final question is how the bank finances its operations, in addition to its equity cushion (recall that we do not have deposits in the model). Our central assumption is that the bank can borrow in financial markets using the securities it holds as collateral. We denote by L_t the stock of short-term borrowing by the bank from the market at time t=1, 2. Because the lending is collateralized, we assume that the lenders always liquidate collateral quickly enough to be left whole, so these loans are safe and bear the interest rate of zero. To keep themselves safe, lenders to the bank insist that the bank must at all times maintain a haircut h in the form of securities on its debt; that is, $L_t = (1-h) \cdot collateral$. We take h to be constant. If haircuts are countercyclical, as argued by Brunnermeier and Pedersen (2009), Adrian and Shin (2009), and Gorton and Metrick (2009), the instability described in our paper becomes more extreme.

Our specification of h captures the short-term collateralized borrowing arrangements, such as asset-backed commercial paper and repo transactions, that have become increasingly prevalent (see Adrian and Shin, 2008, 2009; Fostel and Geanakoplos, 2008; Gorton, 2008; Gorton and Metrick, 2009). In these transactions, banks often borrow on a safe haircut that allows lenders to liquidate the collateral before its value falls below the value of the loan. Consistent with Williamson (1988) and Shleifer and Vishny (1992), securitization encourages this type of borrowing by making the assets retained on bank balance sheets more liquid and redeployable, thereby supporting higher leverage. Indeed, an important side benefit of "true" securitization, with packaging and tranching, is that AAA securities can be used as collateral with very low haircuts.

Because the market prices and liquidity of securities fluctuate over time, the collateralized lending arrangements are typically short term. Any borrower seeking to make these loans longer term would presumably have to accept a higher haircut, thereby decreasing its debt capacity (as well as paying higher interest rates if there is a risk of default). Long-term debt would thus be more expensive. An alternative view is that short-term debt is a disciplinary device against agency problems (Diamond and Rajan, 2001). We suggest instead that banks borrow short term because of redeployable mark-to-market collateral created by securitization and hence the profitability of borrowing and securitizing as much as possible in the boom. We also assume, but do not model explicitly, that banks choose not to raise equity at time 2, perhaps for the usual adverse-selection reasons.

The principal consequences of bank borrowing in our model is that, should the price of securities fall at time 2, the bank might have to liquidate some of its portfolio of securities to maintain the haircut. We denote by S the number of securities the bank sells at time 2. Of course, we also need to consider the case in which the bank chooses to buy more securities at time 2, in which case $S<0$. Security liquidations can quickly wipe out the bank's equity (remember that the lenders to the bank never lose money) but can also create downward price spirals in securities. As we show below, although securitization makes banking highly cyclical even without leverage, leverage exacerbates the volatility.

In Section 3, we consider the case of h=1, so $L_1 = L_2 = 0$; the bank cannot borrow in the market. We compare d=1, which corresponds to traditional lending whereby the bank keeps the loans on its books, with $d<1$, which refers to securitization. We ask when it pays the bank to finance everything it can at t=1 and save no cash, even when additional high projects become available at t=2. We start with $P_1 = 1$, but then turn to $P_1 > 1$. In Section 4, we consider the case of $h<1$, in which the bank is able to borrow in the market to expand its activities. In this case, we examine the liquidation of the securities portfolio at t=2 when $P_2<1$. We again look at both P_1=1 and the bubble, with $P_1>1$. In Section 5, we examine the endogenous determination of P_2.

3. Securitization without bank leverage

In this section, we consider the case of no bank leverage: $h = 1$, $L = 0$. We first deal with the case of $P_1 = 1$, so there are no speculative gains to the bank from underwriting securities. To illustrate the main ideas, we also assume that the bank knows that security prices will fall below 1 at t=2, and that the bank even knows the exact value of $P_2<1$. We are interested in understanding the circumstances under which the bank uses its balance sheet to finance securitization even when it knows that the good times will not last and the market will shortly crash.

3.1. Traditional lending: d=1

To fix ideas, we begin with the case of traditional lending, in which the bank cannot sell project loans in the market. Suppose all projects available at t=1 and 2 are identical. If the bank uses all of its balance sheet in period 1, it lends out all of E_0 to finance $N = E_0$ projects and keeps all of them on its books. The bank collects $E_0 f$ as fees and distributes these profits as dividends (or employee compensation). Since the interest rate is equal to zero, however, it costs the bank nothing to save up half of its capital until t=2, financing an equal number of projects each period. Regardless of how the bank spreads out its financing, it gets its money back at t=3. The central point is that, as we have set up the model, there is no reason for cyclicality of traditional lending. If we assume (as we do in Section 3.3) that there is a limited number of high-return projects each period, the bank has an incentive to smooth its lending over time.

3.2. Securitization $d<1$

Now suppose that the bank can securitize its loans. If it uses up all of its capital at t=1, it can finance $N = E_0/d$ projects and keep $dN = E_0$ in securities on its books as skin in the game. Obviously, $E_0/d > E_0$, so the number of projects financed, and the balance sheet, expand. Also, profits at t=1 are now $fE_0/d > fE_0$. The bank has greatly increased its profitability through securitization. At time 2, security holders and the bank suffer capital losses if $P_2<1$. But these losses lead to no liquidation and are economically irrelevant. Everyone can wait until t=3 to collect \$1 per loan. The bank suffers equity erosion at t=2, but it is inconsequential. In fact, there is no particular economic reason to mark the portfolio to market, because the value of the portfolio serves no economic function without bank leverage.

We need three additional conditions. First, the bank must not want to securitize at t=2 when $P_2<1$. Second, the bank must not want to sell its securities at P_2 and use the proceeds for lending to new projects. The condition for the bank not to sell at t=2 is $(1-P_2)/P_2 > f$, which means that keeping securities for capital gains at t=3 is more profitable than selling them and collecting fees from new firms.[8] Note that $f<1-P_2$ is sufficient for both of these conditions to hold.

[8] It might even be the case that, due to the scarcity of capital, f in period 2 is higher than in period 1 and involves giving the bank all of the surplus. This would make the sufficient condition be f=$Z-1<1-P_2$.

Third, we need to check that the bank does not wish to hoard cash at t=1 to invest in undervalued securities at t=2. If the bank uses all its capital at t=1 for securitization, its profits are $Nf = fE_0/d$. If the bank saves cash C for the second period and invests it in undervalued securities, then its profits are $f(E_0-C)/d + C(1-P_2)/P_2$. The condition for the bank not to hoard any cash, then, is given by

$$\frac{E_0 f}{d} > \frac{E_0 f}{d} - \frac{Cf}{d} + C\left(\frac{1-P_2}{P_2}\right) \tag{1}$$

or

$$\frac{f}{d} > \frac{1-P_2}{P_2}. \tag{2}$$

The profit function in this model is linear in C, so the bank is always at a corner, with either C=0 or C=E_0. It saves either everything or nothing. In our model, the condition for not hoarding cash is likely to hold when d is small and P_2 is not too far below 1. The bank prefers not to hold cash so long as prices are not expected to crash.

If these three conditions hold, the bank does not want to wait for future lending or security buying and uses all of its balance sheet to make securitized loans in period 1. Indeed, there is no new investment at time 2. The bank earns all of its fees at time 1 and none at time 2. The times are so good that the bank wants to expand its balance sheet to the maximum and fund as many projects as it can as fast as it can.

In the model as we have specified it so far, such cyclical activity financed through securitization is more efficient than the smoother financing done by traditional banks —projects add social value, and the more of them that are financed, the better.[9] Securitization makes the banks' profits, as well as real investment, more cyclical than traditional lending, but the benefit of such cyclicality is more activity. As we show below, this efficiency conclusion is not general.

This analysis has a number of implications. First, it shows how investor sentiment, through securitization, infects banking and leads to cyclicality of profits, investment, and the market value of the balance sheet. Banks use up all their capital in booms knowing full well that a crisis will come and that they will suffer (at least book) losses. But they realize that there is so much money to be made during booms that they should nonetheless extend themselves fully.

Second, we can ask what happens if an unanticipated \$1 of equity is injected into the bank at t=2, so it all of a sudden has \$1 of spare capacity. In this case, the return from project finance is f, while the return from buying traded securities is $(1-P_2)/P_2$. The bank will commit the extra dollar to whichever one is more profitable, and we have assumed that it is more profitable in bad times to invest in securities than to lend directly.

This observation has a major implication: if the dislocation of asset prices is severe enough, the bank allocates the capital windfall to buying underpriced securities, so that no capital flows to new investment. This continues to happen until security prices rise enough that $f > (1-P_2)/P_2$. When the markets are dislocated, the rational strategy of the bank is to engage in proprietary trading rather than to finance real investment.

[9] This outcome is not constrained efficient, however, since at t=2 the bank is unwilling to sell assets at fire-sale prices to finance new loans.

3.3. Heterogeneous projects

With identical projects, there is no reason for the bank to smooth its financing, so securitization creates strong pressures for cyclicality. Suppose, alternatively, that the bank has access to some high-payoff projects every period, but not enough that it can stick to funding only those at time 1. Will it pay the bank to wait with some cash until t=2 when more high-payoff projects become available?

When d=1 and there is no securitization, the bank will smooth its investments to benefit from good projects that become available for financing in period 2. Recall that N_H is the number of high-payoff projects per period. If $E_0 \le 2N_H$, the bank will finance $E_0/2$ high projects each period: complete smoothing. If $E_0 > 2N_H$, the bank will finance all high projects and some low projects each period: again, complete smoothing. (More accurately for the second case, the bank will always smooth high projects and is indifferent to smoothing low projects.)

Suppose $d<1$ and there is securitization at t=1, $E_0 > 2N_H$, and $P_2 < 1 - f_H$, so the bank does not want to securitize at t=2. If the bank does not save N_H until t=2 and instead finances and securitizes everything it can at t=1, then its profits are given by

$$\pi_{\text{no save}} = N_H \cdot f_H + \left(\frac{E_0}{d} - N_H\right) f_L. \tag{3}$$

If the bank saves N_H and finances new high projects at t=2, its profits become

$$\pi_{\text{save}} = \left(\frac{E_0 - N_H}{d} - N_H\right) f_L + 2N_H f_H. \tag{4}$$

The condition for the bank using all of its balance sheet to lend to projects at t=1, and saving up nothing for t=2, becomes

$$\pi_{\text{no save}} > \pi_{\text{save}} \text{ iff } \frac{f_L}{d} > f_H. \tag{5}$$

Unless high projects are hugely better than low ones, this condition is likely to hold. The benefits from funding more projects through securitization are so high that the bank forgoes funding some good ones in bad times.

The bank's policy makes investment more cyclical than with d=1, but this is still more efficient than smoothing as long as $(Z_L - 1)/d > Z_H - 1$. This last condition follows directly from Eq. (5) since, by assumption, bank fees are a fixed share of the total net present value of projects financed. If bank profits are higher in the cyclical equilibrium, it is precisely because the total NPV of projects financed is higher in that equilibrium. The alignment of the bank's profitability and social efficiency, which is special to the case of $P_1 = 1$, breaks down when $P_1 > 1$, as we discuss below.

3.4. Bubbles

Finally, we consider what happens when $P_1>1$. Suppose that the bank finances and securitizes all the projects it can. It must keep Nd securities as skin in the game, so $Nd=E_0$. Without leverage, the bank makes no gains from high security prices in terms of expanding its balance sheet. However, period 1 distributed profits are now given by $(P_1-1)(1-d)N+Nf$, which is higher than Nf when $P_1\geq 1$.

The incentives to save cash for undervalued assets, or to wait for the next round of good projects, are now even weaker than before. There is even more cyclicality in profits and the balance sheet because of the greater fluctuation in prices over time. There are still no economic consequences of the decline in the balance sheet at time 2, however.

Perhaps the most interesting change in the model with bubbles concerns the efficiency of investment. Suppose that there are two kinds of projects each period: high ones with $Z_H>1$ (and a positive fee) and low ones with $Z_L=1$ (and a zero fee), and that the high ones are in limited supply. The assumption that low projects have zero net present value is made only to illustrate the point starkly. Suppose that all loans—for both high and low projects—can be securitized at t=1 and sold off at $P_1>1$, but that the price falls below 1 at time 2. So long as P_1 is high enough, it pays the bank to use all of its balance sheet for securitization at time 1, including funding the low projects, and to make *no* loans at time 2, including to the high projects. This is clearly less efficient from the social viewpoint than smoothing the financing over time, at least to the point where all the high projects are financed. Indeed, we can have $Z<1$ and still the project is financed when P_1 is sufficiently above 1. This would require a rebate to borrowers ($f<0$), as when banks offer homeowners teaser rates. In this model, bubbles break the link between social efficiency and bank profits and hence create an intertemporal distortion in favor of excessive financing of less attractive projects during booms.

This distortion becomes even larger if different types of projects vary according to the profitability of securitizing them. This can be modeled as differences among projects in P_1 or d. Projects favored by investor sentiment might fetch particularly high prices P_1, making them the most profitable to securitize. Even if the less favored projects have higher NPVs and correspondingly higher fees paid by borrowers, this benefit could be more than offset by lower securitization profits, encouraging banks to shun these valuable projects. This distortion would be even greater if projects with a high P_1 and a lower NPV could also be securitized with less skin in the game. For example, some corporate loans, although financing particularly socially desirable investments, might be harder to securitize than more homogeneous loans. In this case, bubbles again create a bias toward financing securitizable investments and hence can lead to distortions.

3.5. Summary

The analysis without bank leverage yields five significant conclusions:

(1) Relative to direct lending, securitization raises the level of investment but also its cyclicality, as well as that of balance sheets and profits. It transmits fluctuations in investor sentiment into the real economy through the banking sector.
(2) There is a built-in bias toward funding projects that can be securitized at favorable prices, and against projects that cannot be securitized as easily. With bubbles, this leads to inefficiencies in what is being financed. These inefficiencies can outweigh the welfare gains from securitization.
(3) Banks rationally pursue profits in booms—and accept book losses in busts—because money-making opportunities in booms are so attractive.
(4) In busts, banks hold on to securities because of expected capital gains, rather than liquidate them and make fresh loans to new projects.
(5) Attempts to help out banks in bad times can help stabilize asset prices but not real investment. Banks will engage in proprietary trading, not lending, until the prices of distressed assets come close enough to fundamental value.

4. Securitization and investment with leveraged banks

Suppose that a bank holding securities can borrow in the market using these securities as collateral. We assume that the debt is short term and that security prices do not move too fast, so that lenders can always liquidate the collateral fast enough to be repaid in full. In this case, the interest rate on the debt is zero. The mechanism of making the debt safe is the haircut h that the borrower must meet for the loan to stay in place. When the bank commits all of its resources, i.e., all of its debt and equity, at time 1 to security holdings (to be used as collateral), the definition of the haircut implies that

$$\frac{E_1}{E_1+L_1}=\frac{E_2}{E_2+L_2}=h \text{ as long as } L_i>0. \tag{6}$$

When the period 2 price falls, securities must be liquidated to maintain the haircut.[10]

We again begin with $P_1=1$ and consider what happens if the bank expands its balance sheet to the maximum, i.e., it does not hoard any cash for t=2. We later provide the conditions for this to be the profit-maximizing policy for the bank.

If the bank uses up its entire balance sheet, which now consists of both equity and short-term debt, for securitization purposes, the skin in the game condition

[10] In our model, haircuts work mechanically just like regulatory capital requirements that take the form of a minimum ratio of equity to total assets. Both haircuts and capital requirements force asset sales and the contraction of the bank's balance sheet when security prices fall.

with $P_1 = 1$ is

$$E_0 + L_1 = Nd. \tag{7}$$

The condition for the bank not to exceed its borrowing capacity at t=1 is

$$\frac{E_1}{E_1 + L_1} = h. \tag{8}$$

Solving for the equilibrium number of projects, we obtain

$$N = \frac{E_0}{dh}. \tag{9}$$

Here collateral is $Nd = E_1/h$ and the loan is $L_1 = (1-h)\cdot collateral$. Eq. (9) captures the fundamental mechanisms of balance sheet expansion in our model. The bank finances $1/(dh)$ times its equity in projects. For example, if h=0.2 and d=0.2, then the bank finances 25 times its equity value in projects.

At t=2, when prices fall and $P_2 < 1-f$, the bank obviously cannot originate and distribute loans profitably. Indeed, to maintain the haircut, the bank must now sell securities. Suppose it sells S securities, so that it holds $Nd - S$ securities valued at $(Nd-S)P_2$ at the end of period 2. It uses the proceeds from selling securities to repay P_2S of its loan, so it still owes $L_2 = L_1 - P_2S$ to the lenders. Since all the losses on the securities come from the bank's equity (lenders are at no risk), we can compute the resulting equity and haircut:

$$E_2 = (Nd-S)P_2 - (L_1 - P_2S) = NdP_2 - L_1 \tag{10}$$

$$h = \frac{E_2}{E_2 + L_2} = \frac{NdP_2 - L_1}{(Nd-S)P_2}. \tag{11}$$

If we plug in $L_1 = E_1(1-h)/h$ and $Nd = E_1/h$, we obtain $hNdP_2 - hSP_2 = NdP_2 - L_1$, so

$$S = \frac{E_1}{h}\left[\frac{1-P_2}{P_2}\cdot\frac{1-h}{h}\right]. \tag{12}$$

The bank must liquidate the fraction $(1-P_2/P_2)\cdot(1-h/h)$ of its portfolio.

When h=1, there is no liquidation. When $P_2 = 1-h$, the bank must liquidate everything, so assume $P_2 > 1-h$, i.e., the creditors have not liquidated the entire portfolio.

There are several points to notice about the expression for S. The bank unwinds its portfolio very rapidly as prices fall. If h rises in bad times, it unwinds the portfolio even more rapidly. We can compute some comparative statics on liquidation. First,

$$\frac{dS}{dh} = E_1\left(\frac{1-P_2}{P_2}\right)\left(\frac{h(-2+h)}{h^4}\right) < 0. \tag{13}$$

When the haircut h is smaller, liquidation proceeds more quickly because leverage is higher. So if period 1 was a time of very liquid markets with low haircuts, we expect to see quick liquidations of bank portfolios even without rising haircuts. Second,

$$\frac{dS}{dP_2} = \frac{E_1}{h}\left(\frac{1-h}{h}\right)\left(\frac{1-2P_2}{P_2^2}\right) < 0. \tag{14}$$

The larger is the price shock at time 2, the faster is the liquidation. Recall that we are only looking at modest price shocks and do not consider large (unanticipated) shocks that precipitate complete liquidation and might even entail losses to the lenders.

Leverage changes the situation dramatically relative to the case with no leverage. So long as the full commitment of the balance sheet is an equilibrium, which it is under conditions discussed below, leverage only increases the cyclicality of real investment. Now, however, the bank actually liquidates a part of its portfolio when security prices fall. This means that banks destabilize security prices by selling into a falling market. Moreover, the smaller is the haircut, the greater is the liquidation and this destabilizing role. In Section 5, we consider the endogenous determination of security prices.

The model illustrates the crucial maturity mismatch. Banks borrow short term to underwrite securities that finance long-term projects. With mark-to-market accounting, they might not be able to maintain those investments on their books should the market decline. Banks wish to hold on to these undervalued securities, but they are forced to liquidate by creditors. Recall that the efficient thing to do would be for the banks to sell their security holdings and finance new investments. But securities are underpriced, and the banks would rather own more than they can; they surely do not want to lend to firms.

We next need to establish the conditions under which full commitment of capital to securitization is an equilibrium. We continue to assume that $P_2 > 1-h$, so liquidation keeps the loan safe. The first question is whether, with heterogeneous projects, good projects at t=2 are sacrificed to securitization. To answer that, we compare the profit generated by using a dollar to make securitized loans to low projects at t=1 to the profit generated by using that dollar to make unsecuritized loans to high projects at t=2.

If the bank spends \$1 to make securitized loans to low projects at t=1, it finances $1/(dh)$ projects, holds $1/h$ of these projects on its books, and collects a fee of $f_L/(dh)$. At t=2, it must sell the fraction $\frac{1-h}{h}\cdot\frac{1-P_2}{P_2}$ of its portfolio at a loss $(1-P_2)$ to meet the haircut, which leads to a total loss of

$$\underbrace{\frac{1}{h}\left(\frac{1-h}{h}\frac{1-P_2}{P_2}\right)}_{S}(1-P_2).$$

On net, its profit is

$$\frac{f_L}{dh} - \underbrace{\frac{1}{h}\left(\frac{1-h}{h}\frac{1-P_2}{P_2}\right)}_{S}(1-P_2). \tag{15}$$

If the bank instead uses the dollar to make unsecuritized loans to high projects at t=2, then it finances $1/h$ such projects and collects an up-front fee of f_H/h, so its profit is f_H/h.

Comparing the two profit levels yields the no-waiting condition:

$$\frac{f_L}{d} > f_H + \underbrace{\frac{1-h}{h}\frac{1-P_2}{P_2}(1-P_2)}_{\text{cost of maintaining haircut}}. \tag{16}$$

The advantage of doing everything right away now diminishes by the term in curly brackets in Eq. (16). The reason is that the bank might not be able to maintain its position through the price decline, and has to liquidate it at disadvantageous prices before the loan is paid off for certain at time 3. Because the bank might have to liquidate some or all of its position, waiting is now more attractive even though the benefit of financing new good projects is unchanged at time 2. If the price does not fall too much, this additional term is small, and so it is *still* likely that there are strong incentives to lend to the maximum at t=1. Bank borrowing thus leads to an even greater expansion of the balance sheet at time 1 than before, and to even more extreme volatility of investment.

We also need to check whether banks hoard cash so that they can invest it during the slump. To do this, we compare the profit generated by using a dollar to make securitized loans to finance projects at t=1 to the profit generated by using that dollar to buy underpriced securities at t=2. If the bank makes securitized loans at t=1, it finances $1/(dh)$ projects, holds $1/h$ of these projects on its books, and collects an up-front fee of $f/(dh)$. At t=2, it must sell the fraction $\frac{1-h}{h}\cdot\frac{1-P_2}{P_2}$ of its portfolio at loss $(1-P_2)$ to meet the haircut, which leads to a total loss of

$$\frac{1}{h}\left(\frac{1-h}{h}\frac{1-P_2}{P_2}\right)(1-P_2).$$

On net, it generates a profit of

$$\frac{f}{dh}-\frac{1}{h}\left(\frac{1-h}{h}\frac{1-P_2}{P_2}\right)(1-P_2). \tag{17}$$

If the bank instead saves the dollar, it can buy $(1/h)(1/P_2)$ underpriced securities, yielding a profit of

$$\left(\frac{1}{h}\right)\left(\frac{1}{P_2}\right)(1-P_2). \tag{18}$$

Comparing the two levels of profits yields the no-hoarding-cash condition:

$$\frac{f}{d}>\underbrace{(1-P_2)\frac{1-h}{h}\frac{1-P_2}{P_2}}_{\text{cost of maintaining haircut}}+\frac{1-P_2}{P_2}. \tag{19}$$

This condition is similar to the one before and is one of the key conditions of the model. It states that the bank will leverage fully to securitize as long as the fees from securitization, given by f/d, exceed the costs, given by the sum of the other two terms. The first term represents the bank's capital losses from liquidating some of its securities at $P_2<1$. The amount of forced liquidation is greater when the price drop at time 2 is greater, and approaches the level of the haircut, h. The second term is the value of a lost opportunity to wait and invest in distressed securities at the price P_2 rather than originate loans at the price of 1. If condition (19) is not satisfied, the bank will choose to retain cash rather than leverage fully to securitize. Since the bank's profits are linear in retained cash, it always retains everything or nothing, i.e., it is at a corner.

Condition (19) is more likely to be satisfied the higher is P_2, the higher are the fees per project f, the lower is the required skin in the game d, and the higher is the haircut h. As long as f is positive, there will always exist a critical level d^* such that condition (19) is satisfied for any $d<d^*$. Moreover, condition (19) appears to hold for a wide range of plausible parameter values. For example, if f=0.1 and P_2=0.75, then condition (19) is satisfied for any $d<0.17$ regardless of the level of the haircut.[11] In this case, even a 25% expected price drop does not deter the bank from levering up to securitize.

In sum, we have two cases here. If loan prices at time 1 are high and are not expected to fall too much relative to the fees from securitization, the bank levers up and securitizes all it can. If loan prices are high at time 1 but are expected to fall enough at time 2 to violate condition (19), then the bank will hold cash at time 1.[12]

These conditions also shed light on the reason why banks oppose mark-to-market accounting. In this model, banks are forced to liquidate their positions by creditors when they cannot meet collateral requirements, even though the securities are perfectly sound if held to maturity. The only reason for liquidation is the under pricing of collateral in an inefficient market. If there were no marking to market and collateral were never liquidated, banks could use their balance sheets to underwrite even more securities without fear of portfolio liquidation. The absence of mark-to-market accounting is equivalent to extending the maturity of debt and decreasing the costs of financial distress.

This reasoning is very partial, however. In a more general model, haircuts and interest rates would have to be higher without mark-to-market collateral, whose liquidation protects creditors. As a consequence, banks would in fact be able to borrow less and finance fewer projects. Put differently, bank leverage on good terms is only possible when creditors are protected by mark-to-market accounting. Banks cannot have it both ways: they cannot simultaneously be able to borrow to expand their balance sheets and also rely on nontransparent accounting to hide losses. In fact, banks would have an incentive to agree to mark-to-market accounting in order to raise capital in good times even if regulators did not require them to do so. Hedge funds can borrow precisely because they post liquid collateral to their lenders and mark it to market so that lenders can at all times ascertain the funds' borrowing capacity.

4.1. *Bubbles with leverage*

In the presence of bubbles, with $P_1>1$, the equilibrium assets are given by[13]

$$Nd=\frac{E_1}{hP_1}=\frac{E_0}{1-P_1(1-h)}. \tag{20}$$

[11] We continue to assume that $P_2<1-f$ (no securitization at time 2), but $P_2>1-h$ (debt is riskless).

[12] We can also comment on other cases of potential interest, namely when $P_1<1-f$. If P_1 is low but expected to rise at time 2, the bank will invest in (previously issued) distressed securities, expecting to sell at a profit in the future. If P_1 is low but expected to fall further before returning to 1 at time 3, the bank will hold cash and wait to invest at time 2, as in the case above when condition (19) does not hold.

[13] The calculations for this subsection are presented in our NBER working paper.

This equation explains how the balance sheet of the bank further expands in a bubble. (Note that this condition reduces to the earlier one for $P_1 = 1$.) With leverage, unlike without leverage, we have $dN/dP_1 > 0$. The reason is that the bank retains some securities on its balance sheet as skin in the game, but in a bubble these securities are more valuable than their cost, so the bank's equity rises. Higher equity in turn allows the bank to borrow more and to finance more projects than it could with $P_1 = 1$.

Not surprisingly, the profitability of the bank now becomes even higher during the boom, since it earns profits on securities it sells. As before, bubbles make it only more likely that the bank uses all of its balance sheet to finance securitization at t=1, even if it anticipates that some or all of its portfolio will need to be liquidated later. As before, bubbles create distortions in the financing of investments in favor of projects that are available for financing in booms and that are easier to securitize.

After the bubble collapses, the number of securities the bank sells is given by

$$\frac{E_0}{1-P_1(1-h)}\frac{(1-h)}{h}\frac{(P_1-P_2)}{P_2}, \tag{21}$$

so all of the previous comparative statics hold (h smaller, sell more; P_2 lower, sell more). Also, $\partial S/\partial P_1 > 0$: fixing P_2, a bigger bubble at t=1 leads to more liquidation at t=2.

4.2. Summary

(1) Leverage promotes a further expansion of balance sheets in boom times and generally increases the cyclicality of investment and profits.
(2) Leverage leads to liquidations of bank portfolios at prices below fundamental values in bad times. This can further destabilize prices.
(3) The result that equity injections will not lead to any new real investment might only become stronger if prices fall further with leverage, as banks use fresh capital to pay down debt and avoid liquidating their portfolios at fire-sale prices.

5. Determination of P_2

Until now, we have discussed bank instability in light of exogenous volatility of security prices. But bank instability and sharp declines in security prices are often seen as mutually reinforcing. To deal with this issue, we need to endogenize P_2. In this section, we use a variant of the "limits of arbitrage" model of Shleifer and Vishny (1997) to endogenize prices, with the banks playing the role of arbitrageurs. The key assumption of that model is that there is a downward-sloping demand curve for a given security coming from the noise traders. The equilibrium price is determined by aggregating noise trader and bank demands for each security with outstanding supply.

We focus on period 2. We assume that there is only one type of project and focus again on the equilibrium in which the bank holds no cash at the end of time 1. We make a stability assumption that $h > d$ (Shleifer and Vishny, 1997, have a similar assumption) and continue to assume that the banks do not fully liquidate their positions at time 2:

$$1-f > P_2 > 1-h. \tag{22}$$

To model noise trader demand, we assume that noise traders have unlimited aggregate resources but that their demands for individual securities are unit-elastic. That is, when noise traders have valuations given by $1-\sigma$, where σ is noise trader shock, their total demand for a given security is given by $(1-\sigma)/P_2 = n_2(P_2)$. From Eq. (12), the bank's demand for a given security is $d - S/N$, where

$$S = dN\frac{1-h}{h}\frac{1-P_2}{P_2}$$

is the number of securities the bank sells at time 2. The condition for noise trader shock being mild enough that condition (22) holds is

$$d + \frac{f(h-d)}{h} < \sigma < h. \tag{23}$$

When this condition holds, the bank's demand is

$$b_2(P_2) = d\left[1 - \frac{1-h}{h}\frac{1-P_2}{P_2}\right]. \tag{24}$$

The price of each security is determined by equating the total demand of the banks and the noise traders with the total supply of each security, which is 1:

$$n_2(P_2) + b_2(P_2) = 1. \tag{25}$$

We can now substitute from the demands of noise traders and banks to obtain

$$\frac{1-\sigma}{P_2} + d\left[1 - \frac{1-h}{h}\frac{1-P_2}{P_2}\right] = 1. \tag{26}$$

Solving for P_2, we find

$$P_2 = \frac{h[1+d]-d-\sigma h}{h-d}. \tag{27}$$

Eq. (27) is the expression for the endogenous equilibrium price at time 2. The sensitivity of P_2 with respect to the noise trader shock is given by

$$\frac{dP_2}{d\sigma} = \frac{-h}{h-d}. \tag{28}$$

P_2 is more responsive to shocks when d is large and h is small. When haircuts are small and therefore leverage is high, prices are extremely sensitive to shocks. Leverage is destabilizing in this very precise sense. Indeed, when h is close to d, as it is in our example, the market falls sharply in response to noise trader shocks and there is extreme instability. In equilibrium, the banks will actually get out of the market. In addition, the derivative of P_2 with respect to h is positive, which means that, with more leverage (lower h) for a given shock, P_2 is lower. Leverage is destabilizing in this sense as well.

In this way, levered banks create both systemic risk and economic volatility. By pursuing securitization and funding their security holdings with debt, banks expose themselves to the risk of having to liquidate their portfolios into falling markets. Such asset fire sales bring about further declines in asset prices in bad times, as all banks simultaneously sell and weaken the banking system as a whole. Also, since lower security prices at the bottom present investment opportunities superior to direct lending, banks forgo funding real activity, leading to an economic and not just a financial crisis.

6. The financial crisis and economic policy

In broad terms, the financial crisis of 2007–2009 can be easily outlined. The proximate cause of the crisis is the collapse of the housing bubble in the United States. U.S. home prices tripled between the mid-1990s and 2006, and then fell by about 30% in 2007–2009 (Case, 2008; Mayer, Pence and Sherlund, 2009). The housing bubble was accompanied by a major credit expansion, particularly in the residential mortgage area, but also in corporate loans, commercial mortgages, and credit card finance. Mortgages and other loans were to a significant extent securitized by pooling portfolios of loans together, tranching them into securities with different durations and risks, and then selling them (Coval, Jurek and Stafford, 2009). Securitization was stimulated by huge demand for AAA securities by foreigners, insurance companies, money market funds, and other investors. This demand for mortgage-related securities also led to some decline in lending standards, and perhaps to misleading ratings of these securities by the rating agencies (Benmelech and Dlugosz, 2009; Keys, Mukherjee, Seru and Vig, 2010; Mian and Sufi, 2009). Banks were intimately involved in both underwriting these securities and holding large inventories on their own books, financing them in large part through short-term borrowing.[14]

Thanks to these activities, bank profits grew significantly. Between 2002 and 2006, aggregate net income for U.S. commercial banks increased 50% (Bech and Rice, 2009, Table A.2). For the four largest U.S. bank holding companies by assets, the increases in net income over this period were 129% for Bank of America, 243% for JP Morgan Chase, 41% for Citigroup, and 57% for Wells Fargo (morningstar.com). For JP Morgan Chase, 2002 net income is the average of 2002 and 2003. This smoothing serves to understate the increase in net income over 2002–2006.[15]

As the housing bubble collapsed, mortgages began to default. The summer of 2007 saw rapid declines in the prices of mortgage-related securities, including the AAA-rated bonds often used as collateral against short-term loans. This price collapse effectively ended new securitization. With rapidly falling prices, banks sold their inventories of securities very slowly. Some might have even increased their credit risk exposure through credit default swaps and indices such as ABX. As the banks maintained their exposure to mortgage-related debt, real lending declined in nearly all categories, not just in areas where securitization was prevalent (Ivashina and Scharfstein, 2008). In 2008, the Federal Reserve Bank and then the U.S. Treasury stepped into the crisis by first lending massively to banks against collateral and then moving to equity injections (Veronesi and Zingales, 2008). These expensive rescue attempts did not, at least initially, unfreeze bank lending to businesses. Rather, banks hoarded cash (in the form of deposits at the Federal Reserve) and tried to hold on to their inventories of securities. Eventually, the Fed started buying mortgage-related securities directly.

Our model does not address the housing bubble, but it does speak to the other aspects of the narrative.[16] Most important, the model suggests that banks got themselves into so much trouble not by their irrationality or herding instincts but by taking advantage of extraordinary temporary profit opportunities afforded by securitization. This is not to say that the banks correctly anticipated the depth of the crisis and the troubles that were about to beset them. Banks appear to have recognized the possibility of some home price declines, but nothing as sharp as was about to occur (Gerardi, Lehnert, Willen and Sherland, 2008). The market's optimism about home prices probably accounts for the ability of banks to sell mortgage securities at favorable prices over several years. Banks apparently believed that the profits from these securitizations more than compensated for the risk of losses on their security holdings. This is our interpretation of the now-famous quote by Chuck Prince, then chairman of Citigroup: "When the music stops, in terms of liquidity, things will be complicated. But as long as the music is playing, you've got to get up and dance. We're still dancing." (*Financial Times*, 7/9/07)

From the point of view of policy analysis, the model suggests three broad themes. First, the model identifies a fundamental instability of a system in which banks originate loans to securitize and borrow short term against their own inventories of securities. Many economists have recognized the cyclicality of credit risk-taking and the use of short-term debt as key factors contributing to the financial crisis. Some have attributed this behavior to agency problems within banks or to herding. We show that with modern banking, the forces pushing toward cyclical credit expansion financed by short-term debt are much stronger than previously recognized. It will be difficult to wean the system of this behavior through better corporate governance at banks. In particular, recent proposals to reform compensation policies at banks will not curb procyclical risk-taking as long as this behavior is consistent with long-run value maximization. Procyclical

[14] Many banks (especially non-U.S. banks) that were not involved as securitizers bought securitized loans to gain exposure to the asset class for proprietary or client accounts. These banks would count as outside investors in our model, and their holdings would not be included in the estimate of the parameter d.

[15] One can ask whether the banks actually earned higher profits over this period once we factor in the declines during 2007–2008. To roughly answer this question, we average net income over 2001–2003 and compare it to the average over 2004–2008. For U.S. commercial banks in the aggregate, the 2004–2008 average is only 4.5% higher than the 2001–2003 average, thanks to a huge decline in 2008 (Bech and Rice, 2009). For the largest banks, the results vary. For Bank of America, average net income over 2004–2008 is 55% above that for 2001–2003, for JP Morgan Chase the difference is 188%, for Wells Fargo it is 34%. However, for Citigroup, average net income over the later period is 51% lower than over the former. These numbers suggest that some banks plausibly expected to make money despite the risk of falling prices.

[16] The model takes P_1 as exogenous. We could in principle model the joint determination of home prices, the availability and cost of home finance, and P_1, as suggested by Shleifer and Vishny (1992).

capital requirements and direct regulation of short-term borrowing by banks are needed to dampen cyclical credit fluctuations and control systemic risk.

Second, our model speaks to the desirability of capital requirements (thought of as the ratio of equity to total assets) as a stabilizing strategy. In our model, capital requirements mechanically operate similarly to haircuts: higher requirements limit balance sheet expansions in good times and asset fire sales in bad times. Yet there is a crucial difference. We assume that haircuts are constant, although in reality they are often countercyclical. Countercyclical haircuts are even more destabilizing than the constant ones in the model, since they lead to both more aggressive securitization in good times, and deeper liquidations in bad times. Capital requirements, in contrast, can be chosen by regulators to be both higher than the haircuts on average, and more importantly procyclical, falling during market crises. Higher and procyclical requirements would restrict project financing, securitization, and expansion of bank balance sheets in good times, which might be socially desirable when security prices rise above fundamental values and project choices are distorted. In bad times, the reductions in capital requirements could limit asset liquidations and contraction of bank balance sheets. Procyclical capital requirements would then reduce the volatility of real activity, and improve the efficiency of resource allocation.

Third, getting the economy out of a financial crisis is likely to require addressing not just the liabilities of the banks, such as long-term debt, but also their assets. As long as the banks continue to hold, and can choose to invest in, undervalued securities, the lending mechanisms will be blocked or weakened by the banks' own choice. This is true so long as securities trade at prices below their fundamental values. Unlocking the lending channel requires an increase in security prices, so that trading can no longer compete as profitably with real lending. Our model strongly supports the Fed's recent use of credit easing, in which it purchased large amounts of mortgages and debt of government-sponsored enterprises when the credit spreads on these securities widened to unprecedented levels.

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