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Fire Sales in Finance and Macroeconomics

Andrei Shleifer and Robert Vishny

Analysts of the recent financial crisis often refer to the role of asset "fire sales" in depleting the balance sheets of financial institutions and aggravating the fragility of the financial system. For example, a report from the U.S. Treasury (2009) held: "An initial fundamental shock associated with the bursting of the housing bubble and deteriorating economic conditions generated losses for leveraged investors including banks. . . . The resulting need to reduce risk triggered a wide-scale deleveraging in these markets and led to fire sales." Similarly, a discussion of the crisis by leading American financial economists (French et al., 2010, p. 67) argued: "A bank that simply suffers large losses may be forced to reduce its risk by selling assets at distressed or fire-sale prices. If other banks must revalue their assets at these temporarily low market values, the first sale can set off a cascade of fire sales that inflicts losses on many institutions. Thus, whether through defaults or fire sales, one troubled bank can damage many others, reducing the financial system's capacity to bear risk and make loans." Economists at the Federal Reserve (Carlson, Haubrick, Cherney, and Wakefield, 2009), in explaining the Fed policy of guaranteeing money market funds during the crisis, write: "The effect of the announcement was to permit an orderly management of withdrawals from the money funds, preventing a liquidation of assets at distressed prices, which could have destabilized the funds' net asset values."

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The current crisis is not the first where terminology of a "fire sale" has been used. In 1998 testimony to Congress following the collapse and rescue of the Long-Term Capital Management hedge fund, Fed Chairman Greenspan testified (as quoted in Caballero and Simsek, 2010): "Quickly unwinding a complicated portfolio that contains exposure to all manner of risks, such as that of LTCM, in such market conditions amounts to conducting a fire sale. The prices received in a time of stress do not reflect longer run potential, adding to the losses incurred."

The term "fire sale" has been around since the nineteenth century to describe firms selling smoke-damaged merchandise at cut-rate prices in the aftermath of a fire. But what are fire sales in broad financial markets with hundreds of participants? How can fire sales matter for generic goods, such as airplanes or financial securities? In modern financial research, the term "fire sale" has acquired a different meaning. As we suggested in a 1992 paper, a fire sale is essentially a forced sale of an asset at a dislocated price. The asset sale is forced in the sense that the seller cannot pay creditors without selling assets. The price is dislocated because the highest potential bidders are typically involved in a similar activity as the seller, and are therefore themselves indebted and cannot borrow more to buy the asset. Indeed, rather than bidding for the asset, they might be selling similar assets themselves. Assets are then bought by nonspecialists who, knowing that they have less expertise with the assets in question, are only willing to buy at valuations that are much lower.

Assets sold in fire sales can trade at prices far below value in best use, causing severe losses to sellers. Of course, borrowers and lenders can seek to negotiate and renegotiate contracts to avoid fire sales, but sometimes they fail. Fire sales and efforts to avoid them shed light on a range of empirical phenomena, such as the structure of debt contracts, organization of bankruptcy regimes, and even the failures of arbitrage and market efficiency in financial markets. Fire sales can also lead to fragility of financial markets during crises. When a fire sale leads to a sharp reduction in an asset's price, similar assets held by other market participants decline in value as well, which might bring them also to financial distress and forced asset sales. This self-reinforcing process can lead to downward spirals or cascades in asset prices and net worth of market participants. Because of fire sales, risk becomes systemic. Through this process, asset fire sales and the deterioration of the net worth of firms and financial institutions can severely undermine financial intermediation, leading to reductions of real investment and output.

In this paper, we selectively review some of the research on fire sales, emphasizing both concepts and supporting evidence. We begin by describing our 1992 model of fire sales and the related findings in empirical corporate finance. We then show that models of fire sales can account for several related phenomena during the recent financial crisis, including the contraction of the banking system and the failures of arbitrage in financial markets exemplified by historically unprecedented differences in prices of very similar securities. We then link fire sales to macroeconomics by discussing how such dislocations of security prices and the reduction in balance sheets of banks can reduce investment and output.

Finally, we consider how the concept of fire sales can help us think about government interventions in financial markets, including the evidently successful Federal Reserve interventions in 2009. Fire sales are surely not the whole story of the financial crisis, but they are a phenomenon that binds together many elements of the crisis.

Modeling Fire Sales

A fire sale of an asset is a forced sale, which can occur for a number of reasons. A person might sell his car quickly because he has urgent medical expenses. A mutual fund might sell securities because it faces capital withdrawals by its shareholders (Coval and Stafford, 2007). A firm might quickly sell a division to pay a regulatory fine. However, the most common mechanism that precipitates forced sales of both real and financial assets is collateralized lending. In such lending agreements, collateral is a borrower's pledge of specific property to a lender to secure repayment of a loan. If the borrower defaults on a loan, the borrower forfeits to the lender the property pledged as collateral—sometimes automatically and sometimes through a legal process. Most debt contracts, including mortgages and corporate debt, are collateralized. When the borrower fails to either repay or meet some conditions of the loan, the lender has the right to sell collateral, and might wish for various reasons to do this quickly.

Despite the importance of collateralized lending in the world, the traditional model of corporate finance of Modigliani and Miller (1958) has no role for collateral in supporting debt contracts. In that model, debt is simply a promise of a part of cash flows of the firm. Even second-generation corporate finance models emphasizing asymmetric information, such as Myers and Majluf (1984), leave no room for collateral. These models thus fail to capture what can in situations of financial distress become the central feature of debt contracts.

Models of debt contracts supported by collateral began to appear in corporate finance in the late 1980s, as the field shifted its attention from describing securities in terms of their cash flows to emphasizing their voting and other control rights (Grossman and Hart, 1988; Aghion and Bolton, 1992; Hart, 1995). In an early paper along these lines, Townsend (1979) models debt as a contract that gives the lender the right to investigate the borrower and then seize its cash flows if the borrower defaults on its debt. In this costly state verification model, control over the cash flows shifts from the borrower to the lender after default. More natural models of collateralized debt were proposed in the late 1980s by Hart and Moore (1994, 1995, 1998). In their models, the lender has the explicit legal right to seize and liquidate collateral in the event of a default. The threat of liquidation provides an incentive for the borrower to repay.

In these models, the liquidation value of collateral is taken as exogenous. Although liquidation value can be low for a highly idiosyncratic asset with no

alternative use (Williamson, 1988), there is no reason in these models why liquidation value should be especially low for a generic asset such as a commercial airplane or a financial security. For such assets, the most plausible reason why specialists are not buying is that they themselves are financially constrained. This might happen, for example, when all the industry specialists suffer the same adverse industry-wide or market-wide shock and so are distressed and selling assets, at the same time. The constraints facing industry specialists are the second essential feature of fire sales. An asset fire sale is thus a forced sale in which high-valuation bidders are sidelined, often due to debt overhang problems afflicting many specialists simultaneously (Shleifer and Vishny, 1992).

To describe this situation, we used a version of a model in Hart (1993) and Hart and Moore (1995). An entrepreneur borrows some money from a lender to buy an asset, such as an airplane, used to generate cash flows. The optimal contract is a combination of short-term and long-term senior debt collateralized by the asset, the former used to force liquidation when the project turns out to be bad, the latter used to provide debt overhang that prevents the borrower from borrowing more and wasting money. If the project is bad, the optimal contract calls for the sale of the asset. Unlike Hart and Moore, we considered liquidation as a sale of the asset in a market in which there is a potential high-valuation industry specialist who values the asset a lot, but also low-valuation outsiders, who are not expert at using the asset and hence have lower valuations. For example, if the asset is a plane, and the seller is an airline, the high-valuation industry specialists would be other airlines. In this case, low-valuation outsiders might be financial buyers, who would buy planes to lease them to other airlines.

The key observation is that the specialist industry buyer, who would be the natural candidate for buying the assets, might itself be financially encumbered, and hence unable to bid, at precisely the time when the assets are being liquidated. This would happen, for example, if liquidation is prompted by an industry-wide adverse shock. In the case of airplanes, consider a decline in travel caused by higher perceived terrorism risk, which creates cash shortages and external financing problems for nearly all airlines. If industry specialists do not have, and cannot raise, external funds to bid, the asset in liquidation will need to be acquired by an industry outsider at a lower price than value in best use. The specialists are sidelined. Financially constrained industry buyers have become central to many models, and have been variously referred to as specialists, natural buyers, optimists, and farmers, as we discuss below.

This analysis raises a number of questions. Why don't the lender and the borrower renegotiate, rather than have the lender repossess the asset? Why doesn't the lender, once it has repossessed the asset, hold on to it until market conditions improve? Presumably, it is in everyone's interest to avoid a fire sale. As we discuss below, substantial efforts are often made by market participants to avoid fire sales, by means of both how contracts are structured before the default and finding new financing rather than repossessing the asset after the default. The Coase theorem is hard at work. But such solutions are not always possible.

Borrowers often do not have the cash needed to avoid a fire sale, and cannot raise additional funds because (as in the Hart–Moore optimal financial structure) they face overhang from senior debt. When negotiations do not succeed because additional cash flows cannot be pledged and a high-valuation buyer is not available, a fire sale is difficult to avoid.

There are two related ideas in finance used to explain why some bidders do not bid and hence the price falls below value in best use. Grossman and Miller (1988) introduced the idea of slow-moving capital, arguing that sometimes it takes time for capital to come to the market and in the meantime the price can deviate from fundamental value. The authors had in mind a very short time period, perhaps a few minutes or hours, during which price pressure from a rapid sale would be felt. This theory is a less-compelling account of price dislocations that last for months. Allen and Gale (1994) stress the costs of market participation as the explanation for the absence of some buyers. Allen and Gale's theory is a good explanation for why only industry insiders, and not others, are present in the market at the time of the sale. One still needs an explanation of why, in a fire sale, it is these insiders, and especially the insiders, who are sidelined.

Our model of fire sales yields a notion of liquidity as the difference between market price and value in best use. When market participants are financially unencumbered, liquidation brings prices close to value in best use, and markets are said to be liquid. When, in contrast, market participants—and in particular specialists in using or holding the asset—are financially encumbered, liquidation leads to sale of assets to outsiders at lower prices, and markets are said to be illiquid.

Evidence on Fire Sales of Real Assets

The theory of fire sales raises questions. Do fire sales actually exist? Do they have significant effects on prices? Do firms take actions to avoid them? Do the terms of collateralized loan contracts reflect the risk of fire sales? Are bankruptcy regimes responsive to the risk of fire sales?

The empirical research on fire sales of real assets began with Pulvino's (1998) study of prices of used airplanes. Commercial airplanes present a great advantage for the study of asset sales because the industry is heavily regulated, and as a consequence, an enormous amount is known about each airplane, so that it becomes possible to control for quality. Pulvino compared the prices of planes sold by financially distressed airlines to those sold by the airlines that were not distressed, holding the exact characteristics of the planes constant. He found that used planes sold by distressed airlines bring 10 to 20 percent lower prices than planes sold by undistressed airlines. Similar magnitudes appear in other studies. For example, Campbell, Giglio, and Pathak (forthcoming) report in a study of forced home sales that "foreclosure discounts are on average 27% of the value of the house."

Other research shows that firms try to avoid such sales of assets in illiquid markets. Asquith, Gertner, and Scharfstein (1994) find that, when industry conditions are bad, a debt work-out is more likely than a liquidation. Schligemann, Stulz, and Walkling (2002) study divestitures of business units by U.S. firms, and find that firms are more likely to divest segments from industries with a more liquid market for corporate assets, even when this means keeping some of their worst-performing units. Almeida, Campello, and Heckbarth (2009) show how poorly performing firms agree to be acquired by firms with substantial liquidity, even when there are no synergies in the merger, in order to avoid having to sell assets in illiquid markets. These are clear efforts by firms and their lenders to avoid joint wealth loss in a fire sale.

What about contractual adaptations to the risk of fire sales? Benmelech and Bergman (2008) take advantage of the fact that, in the United States, the acquisition of airplanes by airlines is often financed by individual plane debt contracts. They then consider what happens during renegotiation of debt contracts collateralized by airplanes. They find that airlines successfully renegotiate their lease obligations downward when their financial position is sufficiently poor and when the liquidation value of their fleet is low. What determines an airline's bargaining power is the ability of the lessors to lease the plane to its competitors, which falls when the industry is in distress. Benmelech and Bergman (2009) find that airlines borrow on more attractive terms when airplanes used as collateral have less financially encumbered buyers. Benmelech and Bergman (forthcoming) show quite remarkably that the bankruptcy of an airline raises the cost of capital to its competitors who have similar airplanes. Using a broader sample of industries, Ortiz-Molina and Phillips (2010) also find that firms in industries with more liquid assets (meaning more potential buyers), and during periods of high asset liquidity, face a lower cost of capital. This evidence suggests that lenders to firms are aware of the costs of fire sales and structure debt contracts to take them into account.

Fire sale considerations also play a role in the debate on the optimality of the two main choices in corporate bankruptcy: reorganization (Chapter 11 of the U.S. Bankruptcy Code) or liquidation (Chapter 7). Many economists and legal scholars favor Chapter 7 liquidation, using the argument that auctions generally allocate resources to those who value them most (for example, Baird, 1986). In our 1992 paper, we argued that this logic does not hold when high-valuation bidders in auctions are financially impaired. Indeed, the standard case for Chapter 11 reorganization, while not focusing specifically on fire sales, warns about the risk of lost value arising through piecemeal liquidation of firms for prices substantially below the value in best use. In countries that rely on Chapter 7–style liquidations, such as Sweden, the original lenders to firms finance the liquidation bids, often by the existing management, thus avoiding fire sales (Stromberg, 2000). Subsequent research on a cross-section of countries has confirmed that liquidation can be very costly. In developed countries, in particular, liquidation leads to lower recovery rates for creditors than reorganization (Djankov, Hart, McLiesh, and Shleifer, 2008).

The punch line of corporate finance research is that fire sales of real assets do exist, that they lead to substantial price discounts, and that firms and lenders are aware of these discounts and take them into account both before and after the onset of financial distress. But there is limited drama in fire sales of real assets because firms, unlike financial institutions, do not exacerbate crises when they sell assets in fire sales. Fire sales of financial assets raise new challenges.

Fire Sales of Financial Assets

Fire sales of securities have broader effects than fire sales of real assets because financial investors, such as hedge funds or banks, finance themselves with money that can be withdrawn quickly. Demand deposits in banks are the standard example, but investors in mutual funds and hedge funds can also withdraw funds on short notice. Financial institutions are also typically heavily leveraged, and some of their loans are short-term, collateralized, or both. Many banks fund their activities with commercial paper, which is a debt instrument with duration between a day and several months. Such funding requires almost continuous renewal. More recently, hedge funds and dealer banks financed some of their activities with repurchase agreements, which are extremely short-term loans collateralized by longer-term securities. Adrian and Shin (2010) document high and growing leverage ratios of financial institutions, reaching debt-to-equity ratios of 30 or more for dealer banks. Much of this debt is short-term collateralized loans.

The extreme vulnerability of financial investors to sudden stops in short-term financing can lead to cascades of liquidation. When financial investors are forced to liquidate their holdings, security prices decline. These declines, in turn, prompt further fund withdrawals and collateral calls for both these investors and their competitors. Such self-reinforcing fire sales were central in the recent financial crisis. We begin by describing the relevant mechanisms, and then turn to crisis facts.

In financial economics, the discussion of fire sales of financial assets is intimately related to an older idea of limited arbitrage, which is the central building block of models of market inefficiency and behavioral finance (Shleifer and Summers, 1990). In the standard view of arbitrage, arbitrageurs lean against the wind to correct the mispricing of financial assets—and thus their influence is fundamentally stabilizing. But might it be possible that arbitrageurs lose funds under management, and hence their ability to lean against the wind, at precisely the same time as prices move away from fundamental values and arbitrage opportunities improve? Might arbitrageurs be more likely to exit their positions, rather than doubling up, when prices are most wrong? Might they sell assets in a fire sale?

In Shleifer and Vishny (1997), we connected the ideas of limited arbitrage and fire sales in a model of arbitrageurs, such as hedge funds, who experience capital withdrawals when their performance is poor. Consider an arbitrageur who raises

funds from outside investors and bets against a mispricing of a security which the arbitrageur knows for certain will disappear after some time. Suppose, however, that this mispricing temporarily gets more extreme, and so the arbitrageur loses money. Unfortunately for this arbitrageur, outside investors do not know whether the losses on these positions are due to a temporary deepening of mispricing, or rather to the errors in this arbitrageur's strategies. Absent such knowledge, the outside investors may choose to withdraw capital. If they do so, the arbitrageur who is fully invested has to reduce its position and return capital to investors, even though holding on, or even adding to the holdings, is extremely attractive.

But here comes the problem. It is likely that the arbitrageur is not unique in following a particular strategy. When this arbitrageur and a number of the arbitrageur's competitors who are doing the same thing all face fund withdrawals, they all start liquidating their positions, which only causes mispricing to widen further. This is a fire sale of financial assets, but with an even deeper problem: As arbitrageurs liquidate their positions and mispricing widens, their losses grow, so that fire sales and the withdrawals of funds from arbitrage are self-reinforcing. This feedback effect from growing mispricing to arbitrageur losses causes prices to spiral or cascade away from fundamental values. This process can lead to a complete collapse of the market, or it can be arrested by the entrance of outsiders to support the market when prices fall far enough.

Our 1997 model focused on the withdrawals of investor funds, but a similar and even stronger argument can be made if arbitrageurs finance their positions with debt. In an important paper, Kiyotaki and Moore (1997) develop a macroeconomic model of credit cycles driven by self-reinforcing changes in asset values and availability of collateralized loans. In their model, there is a homogeneous asset called "land." They refer to high-valuation users of land as "farmers," and to low-valuation users as "gatherers." Because farmers are the high-productivity users of land, they borrow as much as they can to invest, using their land holdings as collateral. But suppose that an adverse shock hits farmers' profits. Now their net worth is not as high, and they cannot maintain as high a level of borrowing. Because the farmers are levered up to the maximum, they have to liquidate some land. But all the other farmers are also fully levered up, so the land must be sold to the less-productive gatherers who have some spare debt capacity but value the land less. A fire sale occurs. As land shifts to less-productive gatherers, its fundamental value declines, which reduces its market value as collateral and precipitates further deleveraging and fire sales of land by farmers. The process only stops because gatherers face decreasing marginal productivity, so eventually land becomes so unproductive in their hands and cheap that farmers can afford to hold it. In this way, Kiyotaki and Moore obtain a feedback from the declining value of collateral to further deleveraging by high-valuation users, which results in a downward spiral in prices.

Gromb and Vayanos (2002) present a related model of fire sales leading to widening mispricing in the context of financial arbitrage. In their model, a widening of mispricing can lead to forced deleveraging by arbitrageurs due to a decline of

collateral values, which in turns leads to further widening of mispricing. Equity and credit withdrawals by financiers from arbitrageurs work in the same direction of causing a downward price spiral in the valuation of a mispriced asset.

The workings of our 1997 model and the Gromb–Vayanos (2002) model were seen in the collapse of Long Term Capital Management (LTCM) in 1998 (referred to in the Greenspan testimony mentioned at the start of this paper). LTCM was a heavily leveraged hedge fund that sustained some losses on its positions during the Russian government's bond default in summer 1998. These losses precipitated substantial calls for cash or more collateral by short-term lenders to LTCM, as well as fund withdrawals by its investors. Unable to come up with cash, LTCM had to liquidate its positions in a fire sale, which caused enormous price dislocations and losses for other hedge funds, which then also had to liquidate. The process was stopped before it could run its full destructive course by a takeover of LTCM by a consortium of financial institutions organized by the New York Federal Reserve to "avoid a fire sale liquidation of LTCM's positions" (Edwards, 1999).

An important feature of debt contracts collateralized by securities is time-varying margins often called "haircuts." To protect themselves from default, lenders require borrowers to post a margin, which means that they lend less than 100 percent of the price of the collateral. If the market price of collateral falls, lenders require either more collateral or some cash back, which the borrower has to come up with to avoid having the collateral liquidated by the lender. This mechanism can precipitate a fire sale in two distinct ways. First, as the value of collateral declines, the borrower might be unable to come up with the cash to maintain its loan, and hence the collateral will be liquidated. Second, the margins or haircuts are determined endogenously (Geanakoplos, 2003). A negative shock to collateral can lead to increased price volatility (or alternatively increased disagreement among investors), and thus increased equilibrium margins and haircuts imposed by lenders keen to protect themselves against losses. If that happens, the borrower must come up with still more collateral, or return some cash. This is again extremely destabilizing, since increases in margins force traders to reduce their positions, which can in turn further deepen mispricing.

Several of the mechanisms just described are analyzed together by Brunnermeier and Pedersen (2009), who model the simultaneous determination of security prices and margins. In their model, as security prices fall, margins or haircuts required to borrow using these assets as collateral rise because by assumption volatility increases. They refer to this phenomenon as a decline in "funding liquidity." Unable to meet margin calls, arbitrageurs are forced to sell their securities in a fire sale, making markets illiquid in the sense of prices diverging from values. They refer to this as "market liquidity," similar to the sense of our 1992 paper. The two spirals described by Brunnermeier and Pedersen reinforce each other: as prices fall, margins rise, arbitrageurs sell, and prices fall further, leading to a collapse of both prices and liquidity in a market.

Even before the financial crisis, considerable empirical work documented the significance of limited arbitrage as related to fire sales in permitting deviations of

prices from fundamental values. We describe two strands of this research. The first concerns failures of arbitrage directly. Mitchell, Pedersen, and Pulvino (2007), for example, study merger arbitrage during the crash of 1987 and convertible bond arbitrage in 2005, a time when the convertible bond market imploded following investor withdrawal of equity capital from money-losing hedge funds. They show quite directly the self-reinforcing effects of arbitrageur losses, equity withdrawals, and liquidation of positions, which in turn lead to further losses. Mitchell and Pulvino (2010) present an even more striking study of arbitrage failures during the current financial crisis. The authors look at a range of very common arbitrage strategies involving corporate securities, such as convertible debt arbitrage, credit default swap–corporate debt arbitrage, and several others. They show that in the worst months of the crisis during 2008, arbitrage spreads—differences in the prices of nearly identical securities—reached fantastic levels. For example, convertible debentures normally included in arbitrage trades, and typically mispriced by less than 2 percent, sold at a 10 percent discount.

A second line of research, initiated by Coval and Stafford (2007), focuses on the behavior of mutual funds. These funds are forced to sell securities immediately in response to withdrawals by their investors. Coval and Stafford point out that by focusing on portfolios of stocks that mutual funds hold at the beginning of the quarter, and knowing their returns during the quarter (since mutual funds report net asset values continuously), one can predict roughly which stocks will be sold when investors liquidate their holdings of poorly performing funds at the end of the quarter. This approach turns out to successfully predict future negative returns on the stocks held by poorly performing funds, and has been used in other studies (Dong, 2010; Ellul, Jotikasthira, and Lundblad, 2010; Greenwood and Thesmar, 2009; Jotikasthira, Lundblad, and Ramodarai, 2010).

Fire Sales and the Financial Crisis

To illuminate the significance of fire sales in the recent financial crisis, we start with a generally accepted narrative of the crisis, as summarized in Table 1. We sketch only the most basic outline; more detailed accounts are contained in Brunnermeier (2009), Gorton and Metrick (2010), and Pozsar, Adrian, Ashcraft, and Boesky (2010). The financial crisis was most proximately related to the bubble in the housing market and to the financing of this bubble with mortgage-backed securities. These mortgage-backed securities were created by pooling together portfolios of mortgages and then separating them into tranches such that the most senior tranches were perceived to be virtually safe and rated AAA by credit rating agencies (Coval, Jurek, and Stafford, 2009). Because of this high rating, senior tranches of mortgage-backed securities ended up in the portfolios of institutional investors such as pension funds and insurance companies, but also as highly leveraged investments on the balance sheets of hedge funds, dealer banks, commercial banks, and special investment vehicles guaranteed by these banks.

Table 1
A Narrative of the Financial Crisis

1. A housing bubble inflates in the mid 2000s. Homes are financed by mortgages that are increasingly securitized. Although the quality of mortgages deteriorates, the securities into which these mortgages are packaged are perceived to be safe and receive AAA-ratings.
2. Financial institutions such as banks and dealer banks retain substantial exposure to the real estate market through direct holdings of commercial real estate and direct holdings of mortgage-backed securities, but also through implicit guarantees of special investment vehicles they organize that hold mortgage-backed securities and finance them with commercial paper.
3. Bad news about the housing market in the summer of 2007 surprises investors in AAA-rated mortgage-backed securities and precipitates a sequence of substantial disruptions in financial markets, such as the collapse of the asset-backed commercial paper market. Aggressive liquidity interventions from the Federal Reserve, including lending to market participants against risky collateral, stabilize markets through the summer of 2008 despite continued bad news about housing.
4. In September 2008, several events, including a run on money market funds, nationalization of AIG, Fannie Mae, and Freddie Mac, and particularly the collapse of Lehman Brothers, precipitate a massive financial crisis. Banks' balance sheets contract because of massive losses on assets and withdrawal of short-term financing, which prompts banks to liquidate assets in fire sales. The consequences of fire sales are exacerbated by uncertainty about bank solvency and government policy.
5. In response to their losses and to reduced availability of financing, banks cut lending to firms.
6. The economy slides into a major recession.
7. Starting in October 2008, the government begins massive interventions in financial markets, including equity injections in banks, expansion of lending against risky collateral, but also direct purchases of long-term agency bonds, which sharply reduce the supply of risky bonds in the market. The combination of government interventions eventually stabilizes the financial markets by spring 2009, although the real economy remains sluggish.

There remains a controversy as to why dealer banks were so exposed to mortgage-backed securities. Some of their holdings were surely explained by inventory and other market-making considerations, but some banks were perhaps speculating on the spreads between returns on mortgage-backed securities and the cost of funding these positions with commercial paper and repurchase agreements (Acharya, Schnabl, and Suarez, 2010; Gorton and Metrick, 2010). It also seems likely that many market participants, including the rating agencies themselves, did not understand the risks of mortgage-backed securities (Jarrow, Li, Mesler, and van Deventer, 2007; Coval, Jurek, and Stafford, 2009; Gennaioli, Shleifer, and Vishny, forthcoming). Whatever the true reasons for investor confidence in mortgage-backed securities, the result was that the high-valuation buyers of mortgage-backed securities (and similar asset-backed securities), such as hedge funds and financial institutions, financed some of their holdings with collateralized short-term debt.

As the grim news about the housing market and the safety of AAA-rated securities started to unfurl in 2007, investors in AAA-rated mortgage-backed securities, like many others, were caught by surprise. Some of the short-term funding arrangements, such as asset-backed commercial paper, evaporated. The Federal Reserve

intervened starting in the summer of 2007 by facilitating mergers of troubled financial institutions and lending to others against risky collateral. This series of interventions successfully delayed a major crisis by over a year.

In September 2008, however, as bad news about the housing market and the values of mortgage-backed securities continued to pour in, markets collapsed. The immediate impetus for the collapse was some combination of the run on money market funds investing in the commercial paper of banks, virtual nationalization of the AIG insurance company as well of government-sponsored housing enterprises Fannie Mae and Freddie Mac, and most importantly the bankruptcy of Lehman Brothers investment bank. As these events rolled out in quick succession, many forms of short-term financing, such as commercial paper and repurchase agreements, dried up, forcing banks to shrink their balance sheets. Banks also had to improve the quality of their assets for regulatory purposes, forcing them out of previously safe but now risky securities. To accomplish this, banks sold assets in a market where other banks and financial institutions were themselves liquidating their holdings, resulting in massive price declines and dislocations (Adrian and Shin, 2010). We saw a classic cycle of price collapses and deleveraging described by fire sales models, driven by both capital withdrawals because of declining collateral values and growing haircuts because of increased risk.

In fall 2008, the price of risk rose to unprecedented levels, and financial markets plummeted. But why were the events after September 2008 so much worse than those before? After all, bad news about housing and AAA-rated mortgage-backed securities started arriving in the summer of 2007, and dramatic events, such as the drying up of the asset-backed commercial paper market, started then. In our view, after the Lehman bankruptcy, a much larger proportion of specialist investors were sidelined from bidding for securities than in 2007 or early 2008. Banks sustained massive losses and could not easily borrow to buy assets. The contraction of commercial paper and repo markets eliminated short-term funding that financed the holdings of dealer banks (Adrian and Shin, 2010; Gorton and Metrick, 2010). Hedge funds as well sustained major losses and, if anything, were liquidating their holdings because of investor redemptions and withdrawal of prime broker financing. Before the Lehman bankruptcy, in contrast, liquidity provision by the Federal Reserve kept most of the specialist buyers in the market. With natural buyers of distressed securities sidelined after Lehman, security prices went into a free fall.

The Federal Reserve began to intervene in markets almost immediately after Lehman, injecting equity into commercial banks, expanding lending to financial institutions against risky collateral, guaranteeing the commercial paper markets, and eventually buying hundreds of billions of dollars of risky securities, mostly bonds of Fannie Mae and Freddie Mac. Essentially, the Federal Reserve became the high-valuation holder of risky securities. Between accepting risky collateral as a guarantee for loans on advantageous terms, and removing massive quantities of securities from the market, the Federal Reserve stabilized banks and the financial system by spring 2009. The price of risk fell. The economy remained sluggish, but

a depression was avoided. Importantly, the fundamentals of the economy were probably worse in spring 2009 than earlier; the fact that financial markets stabilized quickly suggests that liquidity problems caused by fire sales were indeed severe after Lehman, and had to be addressed through public interventions. The financial crisis appears to have been a liquidity crisis, not just a solvency crisis.

The fire-sales mechanism unifies several aspects of the propagation of the crisis. It explains how hedge funds, dealer banks, and commercial banks suffered huge financial losses, largely from reductions in the value of their security holdings. It sheds light on massive violations of arbitrage conditions as hedge funds lost their financing (Mitchell and Pulvino, 2010; Krishnamurthy, 2010; Garleanu and Pedersen, 2010). And it explains why investors most reliant on short-term financing were particularly exposed, and pulled back the most. The common theme in all these phenomena is the sidelining of natural buyers of distressed securities, contributing to the near-shutdown of key parts of the financial system.

Fire Sales in Macroeconomic Models

How did fire sales and deterioration of balance sheets of banks lead to a broader economic crisis? How did government policy stabilize the market? In this section and the next, we argue that the fire-sales perspective can shed light on these questions as well.

The idea that asset liquidations can have adverse consequences for real activity has been present in the macroeconomics literature at least since the 1930s. In his debt deflation theory, Fisher (1933) argues that an adverse shock to the value of corporate assets forces firms to sell those assets to meet their debt obligation, and that such asset sales lead to declines in output prices. The resulting deflation raises the real value of debt denominated in nominal terms and forces further liquidations, leading to a vicious debt deflation cycle. Although the theory is not entirely transparent, Fisher offers some impressive data consistent with the story.

For a more modern analysis, we need to explain why fire sales of financial assets such as bonds would entail real consequences. Why would pecuniary effects from mispricing not only transfer wealth from sellers to buyers of securities but also undermine physical capital investment? The financial crisis saw the decline of bank lending to firms and of real investment (Ivashina and Scharfstein, 2010; Campello, Graham, and Harvey; 2010, Kahle and Stulz, 2010). What can explain it?

Bernanke and Gertler (1989) argued that shocks to corporate net worth reduce the ability of firms to post collateral and borrow, and as such undermine corporate real investment. The Kiyotaki and Moore (1997) paper, in addition to modeling price spirals due to deleveraging and fire sales of land by farms, shows that, as land values decline, so does the net worth of farms and their investment. In the crisis, a sharp decline in asset values was inevitable as the housing bubble burst, but fire sales have worsened these declines.

Most attention in the analysis of the crisis has however focused on the declines in balance sheets of banks. Such declines would reduce bank-financed investment through the so-called bank lending channel (Bernanke and Blinder, 1988). As a bank's net worth declines, so does its ability to extend credit. Research establishing the importance of the lending channel is voluminous; Kashyap and Stein's (2000) is among the most convincing papers. Stein (2010) explains how the bank lending channel can account for investment reductions during the crisis.

There are two additional ideas about how fire sales of securities and the reductions in the net worth of banks can undermine investment. Price dislocations resulting from fire sales influence bank decisions about whether to lend to real investment projects, to hold cash, or to pursue other financial investments. Fire sales may increase the attractiveness of the alternatives to financing real investment.

One key alternative is for a bank to hold cash and "keep its powder dry" because it might need cash in the future. The idea that banks might want to hoard liquidity has been around for awhile, going back to Keynes' description of "liquidity preference" as an alternative to real investment. In the context of asset fire sales, in Shleifer and Vishny (1997), we discuss "the hold back effect," whereby financial investors might hoard cash if the possibility of deepening mispricing and improving arbitrage opportunities seems likely. Holmstrom and Tirole (1998) describe liquidity hoarding as a precaution firms or banks use against future liquidity needs. Caballero and Simsek (2010) present an argument for cash hoarding when banks face uncertainty about the solvency of other banks they are dealing with. Several recent papers have looked at these issues in fire-sales models, emphasizing macroeconomic consequences of cash hoarding (Acharya, Shin, and Yorulmazer, forthcoming; Brunnermeier and Sannikov, 2010; Diamond and Rajan, 2010). Consistent with these studies, there is compelling evidence that banks sharply increased their holdings of cash and deposits with the Federal Reserve in 2009, presumably at the expense of lending (He, Kang, and Krishanmurthy, 2010).

In Shleifer and Vishny (2010a), we alternatively argue that real investment must compete with investment in financial assets when bank capital is scarce. We start with the observation that fire sales of assets by deleveraging financial institutions, such as banks, drive the prices of those assets below fundamental values. If price dislocation is extreme enough, banks will choose to invest in underpriced assets rather than lend money to firms, and real investment will suffer. The evidence presented by He, Kang, and Krishnamurthy (2010) and Ivashina and Scharfstein (2010) is consistent with the prediction that banks have used spare balance sheet capacity, including capital injections from the government, to buy securities rather than to lend in the wake of the financial crisis.

The mechanisms we have described focus on the social costs of fire sales after they have occurred. But presumably if market participants consider the possibility of fire sales before they arise, the conditions of borrowing and lending should reflect the risks of fire sales. In this situation, there might be no social losses from pecuniary externalities and no over-borrowing relative to the social optimum. Several studies

have, however, argued that this is not so. Lorenzoni (2008) shows that when firms ignore the effect of fire sales on other firms, the level of borrowing need not be socially efficient. Stein (2010) begins with the crucial observation that, prior to the crisis, many of the securitized mortgages were essentially transformed by financial intermediaries into shorter-term securities, such as commercial paper, that were subsequently sold to investors. In his model, this demand from money market funds for safe short-term assets drove the securitization process and made it profitable. Stein then shows that, because the consequences of fire sales of securities are not fully internalized by banks, the creation of short-term assets was excessive from the social point of view.

An alternative approach to explaining why leverage is socially excessive is to drop the assumption of rational expectations. In Shleifer and Vishny (2010a), we focus on investor optimism in the securitized loan market as a precursor of a crisis. As banks make and securitize loans to cater to investor demand, the incentives of even fully rational banks lead to overexpansion of lending and excessive leverage in good times, but then fire sales and credit crunches in bad times. Such credit crunches create real efficiency losses when good investment projects are not financed.

In Gennaioli, Shleifer, and Vishny (forthcoming), we also dispense with rational expectations, but argue alternatively that during the period of growing home prices and securitization, market participants neglected the risk that home prices could collapse, leading to defaults even on AAA-rated securities. We show that this neglect of small risks could have led to the massive assumption of such risks by risk-averse investors, who then fled to safety when they became aware of the risks they were bearing.

The punch line of this analysis is that the sidelining of natural buyers in fire sales can lead to declines in asset prices and the net worth of financial institutions, which in turn trigger cuts in lending. Fear of future fire sales likewise encourages financial institutions to hoard cash rather than finance investment. The fire-sales mechanism thus entails real, and not just financial, consequences.

Policy Implications

Economic theory suggests that fire sales entail systemic risk and significant externalities. Well-designed government policies aimed at limiting fires sales can therefore improve welfare.

Some policies aim to reduce the chances of a fire-sale scenario arising. Examples of such policies include increases in the capital cushions of financial firms and improvements in the plumbing of the financial system (French et al., 2010; Hanson, Kashyap, and Stein, in this issue). Likewise, policies such as mandating higher haircuts and margins in derivative markets aim to stop the cycle of deleveraging and fire sales before it starts.

Here, we focus on policies that seek to contain and limit the effects of fire sales that are already underway. When the government reacts to a fire sale in progress,

what should it be seeking to accomplish, and what type of intervention is most likely to be beneficial? During fire sales, many key financial institutions such as banks are sidelined due to their inability to access capital. In this setting, two distinct ways to increase bank lending and real investment have been proposed: 1) the government can lend to banks against risky collateral; 2) the government can purchase assets directly or provide subsidies targeted at the purchasers of certain assets.

The relative merits of these two types of interventions have been addressed, albeit briefly, in the recent literature. Diamond and Rajan (2010) support liquidity injections into the banking system over government asset purchases on the grounds that the government is not able to judge whether asset prices are truly dislocated. Conversely, they argue that misguided government purchases could distort asset prices in other directions and even result in losses. On the other side, in Shleifer and Vishny (2010b), we argue that liquidity injections into the banking system may not increase asset prices or lead to new lending to firms. Instead, banks may engage in precautionary hoarding of liquidity or may purchase assets but still leave their prices well below the level at which new lending becomes attractive. A further problem with providing loans or equity to banks is that the government may end up supporting institutions that ultimately fail and perhaps encourage some of the desperate intermediaries to gamble with government funds by taking on more risk. Security purchases can address asset price dislocations directly, without providing extra subsidies to weak or irresponsible banks. To avoid overpaying for assets, government purchases could target potentially less-toxic asset classes, with greater prospects of reviving new lending in the short run and a lower chance of government losses.

The idea of the government buying financial assets may seem suspicious to a number of economists. After all, most economists would not think of the government buying airplanes, even during a fire sale. But buying financial assets during a fire-sale crisis is very different from buying airplanes. First, financial markets have more systemic implications for the rest of the economy than markets for used airplanes. Restoring the balance sheets of banks would unlock the lending channel in a way that restoring the balance sheets of airlines would not. Second, the government would be a terrible owner of airplanes, unable to negotiate leases nearly as efficiently as the private sector. In contrast, the Federal Reserve might be a reasonably efficient owner of certain fixed-income securities, especially if it can mostly avoid buying "lemons" by purchasing the relatively safe ones.

How does the Federal Reserve know that some securities are cheap, rather than reflecting a high risk of insolvency of underlying issuers? Of course, it can never know for sure, but in the aftermath of the Lehman bankruptcy in September 2008, there were many striking indications that illiquidity was a problem. For example, 10-year government agency bonds that the Fed ended up buying were yielding up to 170 basis points more than similar duration Treasury bonds. This compares to a normal spread on agency paper of 10 to 30 basis points. In many other markets, wide credit spreads for the highest quality borrowers pointed to illiquidity rather

than fundamental problems. Even setting credit spreads aside, the Federal Reserve witnessed the near implosions of commercial paper and repo markets, effectively sidelining natural buyers who relied on these markets to finance purchases of risky debt. This too seems to point to fire sales and illiquidity rather than pure solvency problems.

U.S. government policies in response to the financial crisis and to fire sales in particular took various forms. The government bailed out some financial institutions, but also lent money against risky collateral and bought some assets. Prior to the Lehman bankruptcy in September 2008, liquidity provision to financial institutions was the dominant strategy; in 2009, purchases of agency debt became important. We do not know which one of these strategies was ultimately effective in arresting the crisis in spring 2009, although it does appear that pure liquidity injections and rescues of institutions in 2008 were insufficient to stop the slide. Federal Reserve Chairman Bernanke (2009) described the Fed policy of credit easing in winter 2009, and his justifications seem to largely correspond to the analysis of fire sales presented here. In Shleifer and Vishny (2010b), we describe the virtuous circle and the multipliers that arise from government security purchases as market liquidity improves.

What emerges most clearly from the fire-sales models is the complementarity between tough preventive policies to reduce the risk of fire sales and soft policies when a fire sale and financial crisis is underway. The basic prescription is for the government to intervene in markets to stop fire sales quickly, because failure to do so can severely harm the financial system and the economy as a whole. Although the choice is a controversial one, we think there is a case for the government supporting purchases of dislocated securities by market participants, or even buying them directly, rather than supporting weak or poorly run financial institutions. But this type of softness in the face of an actual crisis should be combined with safeguards that minimize the chance that the banking system becomes engulfed in fire sales.

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References

Acharya, Viral V., Philipp Schnabl, and Gustavo Suarez. 2010. "Securitization Without Risk Transfer." Available at SSRN: http://ssrn.com/abstract=1364525.

Acharya, Viral V., Hyun Song Shin, and Tanju Yorulmazer. Forthcoming. "Crisis Resolution and Bank Liquidity." *Review of Financial Studies.*

Adrian, Tobias, and Hyun Shin. 2010. "The Changing Nature of Financial Intermediation and the Financial Crisis of 2007–2009." *Annual Review of Economics*, vol. 2, pp. 603–618.

Aghion, Philippe, and Patrick Bolton. 1992. "An Incomplete Contracts Approach to Financial Contracting." *Review of Economic Studies*, 59(3): 473–94.

Allen, Franklin, and Douglas Gale. 1994.

"Limited Market Participation and Volatility of Asset Prices." *American Economic Review*, 84(4): 933–55.

Almeida, Heitor, Murillo Campello, and Dirk Heckbarth. 2009. "Liquidity Mergers." Available at SSRN: http://ssrn.com/abstract=1362327.

Asquith, Paul, Robert Gertner, and David S. Scharfstein. 1994. "Anatomy of Financial Distress: An Examination of Junk Bond Issuers." *Quarterly Journal of Economics*, 109(3): 625–58.

Baird, Douglas G. 1986. "The Uneasy Case for Corporate Reorganization." *Journal of Legal Studies*, 15(1): 127–47.

Benmelech, Efraim, and Nittai K. Bergman. 2008. "Collateral Pricing." *Journal of Financial Economics*, 91(3): 339–60.

Benmelech, Efraim, and Nittai K. Bergman. 2009. "Liquidation Values and the Credibility of Financial Contract Renegotiation: Evidence from U.S. Airlines." *Quarterly Journal of Economics*, 123(4): 1635–77.

Benmelech, Efraim, and Nittai K. Bergman. Forthcoming. "Bankruptcy and the Collateral Channel." *Journal of Finance*.

Bernanke, Ben S. 2009. "The Crisis and the Policy Response." Speech, Stamp Lecture at the London School of Economics, London, January 13, 2009.

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

Bernanke Ben S., and Mark Gertler. 1989. "Agency Costs, Net Worth, and Business Fluctuations." *American Economic Review*, 79(1): 14–31.

Brunnermeier, Markus. 2009. "Deciphering the Liquidity and Credit Crunch 2007–08." *Journal of Economic Perspectives*, 23(1): 77–100.

Brunnermeier, Markus, and Lasse H. Pedersen. 2009. "Market Liquidity and Funding Liquidity." *Review of Financial Studies*, 22(6): 2201–38.

Brunnermeier, Markus, and Yuliy Sannikov. 2010. "A Macroeconomic Model with a Financial Sector." http://www.princeton.edu/~markus/research/papers/macro_finance.pdf.

Caballero, Ricardo J., and Alp Simsek. 2010. "Fire Sales in a Model of Complexity." MIT Department of Economics Working Paper No. 09-28. Available at SSRN: http://ssrn.com/abstract=1496592.

Campbell, John Y., Stefano Giglio, and Parag Pathak. Forthcoming. "Forced Sales and House Prices." *American Economic Review*.

Campello, Murillo, John R. Graham, and Campbell R. Harvey. 2010. "The Real Effects of Financial Constraints: Evidence from a Financial Crisis." *Journal of Financial Economics*, 97(3): 470–87.

Carlson, John, Joseph G. Haubrick, Kent Cherney, and Sarah Wakefield. 2009. "Credit Easing: A Policy for a Time of Financial Crisis." Federal Reserve Bank of Cleveland. http://www.clevelandfed.org/research/trends/2009/0209/02monpol.cfm.

Coval, Joshua D., Jakub W. Jurek, and Erik Stafford. 2009. "The Economics of Structured Finance." *Journal of Economic Perspectives*, 23(1): 3–25.

Coval, Joshua D., and Erik Stafford. 2007. "Asset Fire Sales (and Purchases) in Equity Markets." *Journal of Financial Economics*, 86(2): 479–512.

Diamond, Douglas W., and Raghuram G. Rajan. 2010. "Fear of Fire Sales and the Credit Freeze." NBER Working Paper 14925.

Djankov, Simeon, Oliver Hart, Caralee McLiesh, and Andrei Shleifer. 2008. "Debt Enforcement around the World." *Journal of Political Economy*, 116(6): 1105–49.

Dong, Lou. 2010. "A Flow-Based Explanation for Return Predictability." Available at SSRN: http://ssrn.com/abstract=1468382.

Edwards, Franklin. 1999. "Hedge Funds and the Collapse of Long Term Capital Management." *Journal of Economic Perspectives*, 13(2): 189–210.

Ellul, Andrew, Pab Jotikasthira, and Christian T. Lundblad. 2010. "Regulatory Pressure and Fire Sales in the Corporate Bond Market." Available at SSRN: http://ssrn.com/abstract=1362182.

Fisher, Irving. 1933. "The Debt Deflation Theory of the Great Depression." *Econometrica*, 1(4): pp. 337–57.

French, Kenneth R., et al. 2010. *The Squam Lake Report*. Princeton University Press: Princeton, NJ.

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

Geanakoplos, John. 2003. "Liquidity, Default, and Crashes: Endogenous Contracts in General Equilibrium." In *Advances in Economics and Econometrics: Theory and Applications, Eighth World Congress*, Vol. II, ed. Mathias Dewatripont, Lars Peter Hansen, and Stephen J Turnovksy, 170–205. Cambridge University Press.

Gennaioli, Nicola, Andrei Shleifer, and Robert W. Vishny. Forthcoming. "Neglected Risks, Financial Innovation, and Financial Fragility." *Journal of Financial Economics*.

Gorton, Gary, and Andrew Metrick. 2010. "Securitized Banking and the Run on Repo." NBER Working Paper 15223.

Greenwood, Robin, and David Thesmar. 2009. "Stock Price Fragility." Harvard Business School

Research Paper 10-031. Available at SSRN: http://ssrn.com/abstract=1490734.

Gromb, Denis, and Dimitri Vayanos. 2002. "Equilibrium and Welfare in Markets with Financially Constrained Arbitrageurs." *Journal of Financial Economics*, 66(2–3): 361–407.

Grossman, Sanford J., and Oliver Hart. 1988. "One Share–One Vote and the Market for Corporate Control." *Journal of Financial Economics*, 20(1/2): 175–202.

Grossman, Sanford J., and Merton H. Miller. 1988. "Liquidity and Market Structure." *Journal of Finance*, 43(3): 617–33.

Hart, Oliver. 1993. "Theories of Optimal Capital Structure: A Managerial Discretion Perspective." In *The Deal Decade: What Takeovers and Leveraged Buyouts Mean for Corporate Governance*, ed. Margaret Blair. Washington, DC: The Brookings Institution.

Hart, Oliver. 1995. *Firms, Contracts, and Financial Structure*. Oxford: Oxford University Press.

Hart, Oliver, and John Moore. 1994. "A Theory of Debt Based on the Inalienability of Human Capital." *Quarterly Journal of Economics*, 109(4): 841–79.

Hart, Oliver, and John Moore. 1995. "Debt and Seniority: An Analysis of the Role of Hard Claims in Constraining Management." *American Economic Review*, 85(3): 567–85.

Hart, Oliver, and John Moore. 1998. "Default and Renegotiation: A Dynamic Model of Debt." *Quarterly Journal of Economics*, 113(1): 1–41.

He, Zhigou, In Gu Kang, and Arvind Krishnamurthy. 2010. "Balance Sheet Adjustments in the 2008 Crisis." *IMF Economic Review*, 58(1): 118–56.

Holmstrom, Bengt, and Jean Tirole. 1998. "Private and Public Supply of Liquidity." *Journal of Political Economy*, 106(1): 1–40.

Ivashina, Victoria, and David S. Scharfstein. 2010. "Bank Lending during the Financial Crisis of 2008." *Journal of Financial Economics*, 97(3): 319–38.

Jarrow, Robert, Li Li, Mark Mesler, and Donald van Deventer. 2007. "CDO Valuation: Fact and Fiction." Kamakura Corporation Paper. (Privately printed working paper.)

Jotikasthira, Chotibhak, Christian T. Lundblad, and Tarun Ramadorai. 2009. "Asset Fire Sales and Purchases and the International Transmission of Financial Shocks." CEPR Discussion Paper No. DP7595. Available at SSRN: http://ssrn.com/abstract=1533200.

Kahle, Kathleen, and René M. Stulz. 2010. "Financial Policies and the Financial Crisis: How Important Was the Systemic Credit Contraction for Industrial Corporations?" NBER Working Paper 16310.

Kashyap, K. Anil, and Jeremy C. Stein. 2000. "What Do a Million Observations on Banks Say about the Transmission of Monetary Policy?" *American Economic Review*, 90(3): 407–28.

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

Krishnamurthy, Arvind. 2010. "How Debt Markets Have Malfunctioned in the Crisis." *Journal of Economic Perspectives*, 24(1): 3–28.

Lorenzoni, Guido. 2008. "Inefficient Credit Booms." *Review of Economic Studies*, 75(3): 809–33.

Mitchell, Mark, Lasse H. Pedersen, and Todd Pulvino. 2007. "Slow Moving Capital." *American Economic Review*, 97(2): 215–20.

Mitchell, Mark, and Todd Pulvino. 2010. "Arbitrage Crashes and the Speed of Capital." Available at SSRN: http://ssrn.com/abstract=1628261.

Modigliani, Franco, and Merton Miller. 1958. "The Cost of Capital, Corporation Finance and the Theory of Investment." *American Economic Review*, 48(3): 261–97.

Myers, Stewart C., and Nicholas Majluf. 1984. "Corporate Financing and Investment Decisions When Firms Have Information That Investors Do Not Have." *Journal of Financial Economics*, 13(2): 187–221.

Ortiz-Molina, Hernán, and Gordon M. Phillips. 2010. "Asset Liquidation and the Cost of Capital." NBER Working Paper 15992.

Pulvino, Todd. 1998. "Do Fire-Sales Exist? An Empirical Study of Commercial Aircraft Transactions." *Journal of Finance*, 53(3): 939–78.

Pozsar, Zoltan, Tobias Adrian, Adam Ashcraft, and Hayley Boesky. 2010. "Shadow Banking." Federal Reserve Bank of New York Staff Report 458.

Schligemann, Fredrik P., René M. Stulz, and Ralph A. Walkling. 2002. "Divestitures and the Liquidity of the Market for Corporate Assets." *Journal of Financial Economics*, 64(1): 117–44.

Shleifer, Andrei, and Lawrence H. Summers. 1990. "The Noise Trader Approach to Finance." *Journal of Economic Perspectives*, 4(2): 19–33.

Shleifer, Andrei, and Robert W. Vishny. 1992. "Liquidation Values and Debt Capacity: A Market Equilibrium Approach." *Journal of Finance*, 47(4): 1343–66.

Shleifer, Andrei, and Robert W. Vishny. 1997. "The Limits of Arbitrage." *Journal of Finance*, 52(1): 35–55.

Shleifer, Andrei, and Robert W. Vishny. 2010a. "Unstable Banking." *Journal of Financial Economics*, 97(3): 303–18.

Shleifer, Andrei, and Robert W. Vishny. 2010b. "Asset Fire Sales and Credit Easing." *American Economic Review*, 100(2): 46–50.

Stein, Jeremy C. 2010. "Monetary Policy as a Financial-Stability Regulation." http://www.economics.harvard.edu/files/faculty/57_Monetary%20Policy%20as%20Regulation%20April%202010.pdf.

Stromberg, Per. 2000. "Conflicts of Interest and Illiquidity in Bankruptcy Auctions: Theory and Tests." *Journal of Finance*, 55(6): 2641–91.

Townsend, Robert M. 1979. "Optimal Contracts and Competitive Markets with Costly State Verification." *Journal of Economic Theory*, 21(2): 1011–46.

United States Treasury. 2009. *Public–Private Investment Program.* Press Release, March 29.

Williamson, Oliver. 1988. "Corporate Finance and Corporate Governance." *Journal of Finance*, 43(3): 567–91.