The Information View of Financial Crises

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Abstract
Short-term debt that can serve as a medium of exchange is designed to be information insensitive. No one should be tempted to acquire private information to gain an informational advantage in trading that could destabilize the value of the debt. Short-term debt minimizes the incentive to acquire information among all securities of equal value backed by the same underlying asset. Moreover, backing short-term debt with debt (i.e., using debt as collateral) minimizes information sensitivity across all types of collateral with equal value. These features are consistent with financial crises occurring periodically. In the information view adopted here, a financial crisis can occur when the collateral backing the short-term debt is thought to have lost enough value to raise doubts among the traders that some may acquire private information. In a crisis, there is a shift from information-insensitive to information-sensitive debt.
Every banker knows that if he has to prove that he is worthy of credit... in fact his credit is gone.

—Walter Bagehot

1. INTRODUCTION

A security is said to be information insensitive if the benefit of producing costly private information about a security’s payoff outweighs the cost; otherwise, the security is information sensitive. Some securities, especially short-term bank debt, are specifically designed to be information insensitive. What are the implications of designing securities to be information insensitive? In this review, we investigate the research on these issues.

The reason for issuing information-insensitive debt was articulated by Gorton & Pennacchi (1990), who argued that such securities are desired by uninformed agents for transactions in which they may face privately informed traders to whom they lose money in transactions. Dang, Gorton & Holmström (2018) introduced the concept of information sensitivity and used it to show both that debt is least information sensitive and that the optimal collateral for backing that debt is itself debt. In these authors’ two-period trading model, debt-on-debt is the optimal contract. Such debt maximizes the amount of trade that an uninformed agent can conduct without fearing that the counterparty will collect private information. In fact, all money-like instruments are debt-on-debt. In the USA, free banknotes were backed by state bonds, national banknotes were backed by government bonds, demand deposits are backed by the loan portfolio of the bank, repo is backed by a debt collateral, a mortgage-backed security (MBS) is backed by mortgage debt, and so on. Thus, the rationale for tranching cash flows is to create an information-insensitive debt contract.

In the model presented by Dang, Gorton & Holmström (2018), a financial crisis is an information event. When there is adverse news about the fundamental value of the collateral that backs short-term debt, the price or fair value of the debt declines. More importantly, the information sensitivity of the short-term debt increases. Therefore, information-insensitive debt could become information sensitive, because sophisticated investors have an incentive to acquire private information (if they can). To maintain information insensitivity in money markets, less debt can be issued (in the case of a repo, the haircut, or discount, can be increased), the maturity can be shortened, or collateral can be added. Sometimes these measures are insufficient. A bank run may occur if information insensitivity cannot be maintained. In that case, no one wants the debt for fear of adverse selection. Such an event is a financial crisis. Indeed, financial crises are precisely events in which this regime switch happens: Information-insensitive debt becomes information-sensitive debt. This switch is a loss of confidence. The crisis occurs because there is no price discovery market to fall back on. Instead, quantities have to adjust. In the recent crisis, for example, the asset-backed commercial paper (ABCP) market dried up: Quantities went to zero (Covitz, Liang & Suarez 2013). And haircuts on some categories of collateral backing repo went to 100% (i.e., there was no lending) (Gorton & Metrick 2012).

Why is information-insensitive debt produced if it is vulnerable to a systemic bank run? As alluded to above, agents need a way to efficiently transact, which requires using a security that is always valued and trades against cash one to one. This was not always the case, for example, in the USA during the pre–Civil War period, when private banknotes were used to transact. Banknote discounts (the haircuts from par) varied over time and over geography. Transacting with such claims was difficult because of uncertainty about the accuracy of the discounts. Attempting to produce information-insensitive private money has occupied humans for centuries (see Gorton 2017).
The defining characteristics of money markets are the polar opposites of those of stock markets. Stock markets are secondary markets, with all trade occurring on organized exchanges involving a lot of information production by analysts. By contrast, money markets are primary markets, with most of the trade occurring over the counter and little information produced (see Holmström 2015). In this review, we focus on empirical research that bears on three of the defining characteristics of money markets as a system: information insensitivity, nonprice adjustment, and the deleterious effects of transparency.

Empirical researchers have drawn implications beyond Dang, Gorton & Holmström (2018) to motivate empirical work consistent with broad characterizations of securities by their degree of information sensitivity. For example, some studies show that sophisticated investors (institutions) and unsophisticated investors behaved differently in crises in terms of information production. There are also cases in which holders of short-term debt have distinguished between banks during a crisis, not rolling over the debt of some banks but rolling over the debt of other banks. The model by Dang, Gorton & Holmström (2018) is about primary short-term debt markets, but researchers have analyzed the secondary markets for corporate and municipal bonds in terms of information sensitivity. Other studies show how debt responds when its information environment changes because of either the introduction of credit default swaps (CDSs) or regulation. We review the most important of these studies.

In Section 2 we discuss the historical basis for producing information-insensitive debt and its theoretical rationale. In Section 3 we discuss empirical research on quantity adjustment, information production, and the switch from information-insensitive to information-sensitive debt. In Section 4 we focus on empirical research on corporate and municipal bonds. Section 5 concludes with a brief discussion of policy issues.

2. PRIVATE INFORMATION PRODUCTION, OPACITY, AND LIQUIDITY

In this section we briefly review historical problems with a privately produced medium of exchange that is not information insensitive. Then we turn to a short summary of the theory and the implications of the theory for notions of liquidity.

2.1. Private Money in Pre–Civil War America

The problem for uninformed agents is most easily seen in the US pre–Civil War era (i.e., prior to 1863), when banks issued their own private currencies.1 Hundreds of these currencies circulated at discounts from par in transactions some distance from the issuing bank. These monies were information sensitive. For example, Figure 1 shows the discounts from par (the haircuts) on Bank of Virginia banknotes when used in transactions in Philadelphia. A discount or haircut is designed to recover information insensitivity in the face of some information that has arrived or that might arrive from some distance away. These discounts (or prices) were quite volatile but efficient in the Fama sense. The discounts reflected the various risk factors of individual US states, for instance, whether branch banking was allowed in the state, whether state insurance schemes existed, or the type of bank charter. As a result, banknote systems were not characterized by the chaotic wildcat banking and overissuance problems that have often been alleged (e.g., Friedman 1959; see Gorton 1996, 1999).

1Private banknotes were issued by banks in many countries. Schuler (1992) finds 60 cases of such free banking in history.
Nevertheless, while note markets were efficient, banknotes were not economically efficient. Questions about the value of a note proffered in a transaction regularly occurred. There were disputes and court cases over the value of particular notes. It was simply hard and costly to actually transact (and write contracts) using banknotes. For example, according to Sumner (1896, p. 455):

It is difficult for the modern student to realize that there were hundreds of banks whose notes circulated in any given community. The “bank notes” were bits of paper recognizable as a species by shape, color, size and engraved work. Any piece of paper which had these appearances came with the prestige of money; the only thing in the shape of money to which the people were accustomed. The person to whom one of them was offered, if unskilled in trade and banking, had little choice but to take it. A merchant turned to his [bank note] “Detector” [a newspaper]. He scrutinized the worn and dirty scrap for two or three minutes, regarding it as more probably “good” if it was worn and dirty than if it was clean, because those features were proof of long and successful circulation. He turned it up to the light and looked through it, because it was the custom of the banks to file the notes on slender pins which made holes through them. If there were many such holes the note had been often in bank and its genuineness was ratified. All the delay and trouble of these operations were so much deduction from the character of the notes as current cash.

The phrase “if unskilled in trade and banking” refers to uninformed traders who “had little choice but to take it.” This problem had been recognized by, for example, Ricardo (1816, p. 409):

In the use of money, everyone is a trader; those whose habits and pursuits are little suited to explore the mechanism of trade are obliged to make use of money, and are no way qualified to ascertain the solidity of different banks whose paper is in circulation; accordingly, we find that men living on limited incomes, women, labourers, and mechanics of all descriptions, are often severe sufferers by the failure of country banks.

And the uninformed traders lost money. According to McCulloch (1879, p. 972):

The losses that the people sustained...could be counted by millions. The losses to which they were subjected in traveling from State to State and in making exchanges were greater still. The State bank
system was a system under which bank-note brokers [informed traders] were enriched, and the people [uninformed traders] defrauded.

Private banknotes did not trade one to one for cash, making transactions costly. And the exchange ratio varied. The resulting problems motivated the search for a more efficient form of debt, which at that time was the development of demand deposits and, in the US government, entry into money provision.

2.2. Theory

In this subsection we summarize the main results obtained by Dang, Gorton & Holmström (2018), explaining information insensitivity and crises. Subsequently, we articulate some of the implications and extensions of these results that other researchers have proposed to do empirical work.

Suppose an agent is considering trading for a security offered at price $p$ (perhaps the agent is selling goods or services, for example). The payoff of the security is $s(x)$, where $x$ is a random variable with density $f(x)$, and $E[s(x)]$ is its expected value. The agent offered the security can produce private information about the exact realization $x$ at a cost $\gamma$. What is the value of producing private information? Is it worth paying the cost?

If $p < E[s(x)]$, then the security is viewed as being undervalued. If the agent were to produce information and learn $x$, then he would not buy the security in states where $s(x) < p$ because he would realize a loss of $p - s(x)$. Integrating over all $x$ where $s(x) < p$ gives the expected loss of the buyer in low-payoff states. We define $\pi_L(p) = \int \max[p - s(x), 0] f(x) dx$ as the information sensitivity of a security in the loss region. If $p > E[s(x)]$, then the security is viewed by a potential buyer as overvalued. The agent would not buy the security unless he produced information. In this case, the buyer makes a profit if he produces information and finds that $s(x) > p$. We define the information sensitivity in this case as $\pi_R(p) = \int \max[s(x) - p, 0] f(x) dx$, which measures the expected profit of a security in high-payoff states, in other words, the loss if the transaction is forgone (see Figure 2 for an illustration showing $\pi_L$ and $\pi_R$). The two measures are identical if $p = E[s(x)]$. Dang, Gorton & Holmström (2018) show that the value of information is $\pi = \min[\pi_L, \pi_R]$ for any price $p$ and any distribution $F(x)$ and irrespective of whether the trader is a buyer or a seller.

![Figure 2](https://www.annualreviews.org/)

The value of information.
Figure 3
Contractual payoff on debt. The height of the flat portion is the face value or principal amount of the contract. The 45° line starting at the kink corresponds to the debt holder obtaining all of the payoffs of the project if the borrower cannot repay the principal amount (bankruptcy). The x axis shows the value of whatever collateral is backing the contract, such as a loan or bond portfolio, a specific bond, or payoffs from a project. The orange curve represents the Black–Scholes value of the bond.

Faced with a price, the counterparty compares the value of information, \( \pi \), with the cost of producing the information, \( \gamma \). If \( \pi > \gamma \), then it is profitable to produce information. Evidently, there are two ways to make a security information insensitive: Either lower the value of information, \( \pi \), or raise the cost of producing information, \( \gamma \). We say that a security is information insensitive if no agent finds it profitable to produce private information about the payoffs to the security and all agents know that this is the case. The cost of producing the private information is greater than the expected value of the information. In this sense, the security is viewed as safe.

Figure 3 provides some intuition for information insensitivity. The figure shows the contractual payoff on a debt contract, the usual hockey stick–like profile. The height of the flat line is the face value or principal amount of the contract. The 45° line starting at the kink corresponds to the debt holder obtaining all of the payoffs of the project if the borrower cannot repay the principal amount (bankruptcy). The line representing the Black–Scholes value of the bond detaches from the flat part before the kink, indicating when the bond may be information sensitive. Still, if the cost of producing information is high enough, no agent will produce information. In general, if the cost of information production is nontrivial, and if counterparties (rationally) share the view that the collateral value is far enough to the right, then the value of information production will be such that the debt will be information insensitive. The empirical evidence for this idea is discussed in the next section.

Dang, Gorton & Holmström (2018) show that, among all securities, debt is the least information sensitive. It has the lowest \( \pi \) value. There is no need for an agent to turn the bank note “up to the light and [look] through it.” In other words, trade is most efficiently conducted when agents do not collect information and when each agent knows that other agents have the same belief, in which case there is no adverse selection and no fear of adverse selection. The liquidity provision is precisely the ability to trade without fear of endogenous adverse selection, that is, when no information is produced.

In contrast, Townsend (1979) argues that the purpose of debt is to force firms to release cash to lenders. Lenders produce information about a borrower’s project payoff only if the borrower defaults. Then the lender pays a cost to learn the true state of the firm. The lender does not care
about the state of the firm if the debt is repaid. In this case, it would be desirable for the cost of producing information to be as low as possible. In contrast, information-insensitive securities are designed so that the cost of producing information is high. In fact, a cost of infinity would be best.

How can the information insensitivity of debt be maximized? Dang, Gorton & Holmström (2018) show that, among all securities, the debt should be backed by debt as collateral: Debt-on-debt maximizes information insensitivity. The intuition is straightforward. If debt itself is least information sensitive, then backing it by debt makes it even more so. In fact, this is what we observe. Short-term debt is always backed by debt. Demand deposits are backed by bank loans, repo is backed by a specific bond, ABCP is backed by asset-backed securities (ABS), and so on. Debt-on-debt is quintessentially banking. Furthermore, Dang et al. (2017) argue that banks keep the nature of their loans secret to make it hard to produce information about the bank.

Debt-on-debt is the best structure for making short-term debt information insensitive, in other words, for creating an instrument with a price that does not change. But when there is adverse news about the fundamental value of the debt collateral that backs the tradable debt, the price or fair value of that debt declines. Although the price declines, the information sensitivity of the tradable debt increases. Therefore, some sophisticated investors have an incentive to privately learn more about the payoff and the value of debt, which creates a fear of adverse selection. Formally, the price or fair value of debt is 

\[ p = V = \min(x,D) \int dF(x), \]

where \( D \) is the face value of debt and \( F(x) \) is the distribution of the collateral \( x \). The information sensitivity is 

\[ \pi_L(x) = \max(p - \min(x,D),0) \int dF(x). \]

When public information about \( F(x) \) arrives, it changes the value and price of debt as well as its information sensitivity. Even though a change in \( F(x) \) leads to a decline in \( p \) (i.e., the area labeled \( \pi_L \) in Figure 2 becomes smaller), this can increase the information sensitivity because there is more probability mass in the lower tail.

When there is adverse news about the fundamental value of the debt collateral that backs the tradable debt, suddenly there may be no market for the collateral; it is viewed as a lemons market.\(^2\) Although no one has invested in the technology for understanding how to value the collateral, such as subprime MBS, agents are not sure that there are no privately informed agents. Hansen & Sunderam (2013) and Pagano & Volpin (2012) discuss why collateral is produced to be information insensitive in the primary market, but then has implications for the secondary market if bad news arrives.

In standard finance theory, interest rates vary with default risks. A haircut as a response to a change in default risks constitutes a kind of puzzle from the standard finance view. Why not simply raise the interest rate? Consider a loan with size \( L \) that is collateralized by an asset \( x \), where \( x \) pays off either zero with probability \( q \) or greater than zero with probability \( 1 - q \). In the low state, the loan defaults. The lender breaks even if the repayment \( D \) is such that \( (1 - q) \times D = L \) or \( D = L/(1 - q) \), so the break-even interest rate is \( r = D/L - 1 \). If default risk \( q \) increases, then the interest \( r \) increases. This is the standard theory. Why would a lender demand a haircut when default risk increases? The information sensitivity (or expected loss) of the loan is \( \pi_L = q \times L \). If default risk \( q \) increases, then the information sensitivity of a loan increases. Suppose sophisticated loan investors have information costs \( \gamma \). When default risks increase such that the threshold \( \pi_L = \gamma \) is exceeded, there is a regime switch, and the only way to recreate information insensitivity of a loan is to reduce the loan size \( L \) such that \( L = \gamma/q \). The higher the default risk is, the smaller the loan will be. But no one is sure that default risk has increased, and agents might, if they can, produce private information about this. Rather than increase the interest rate, investors

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\(^2\) The existence of prices does not mean there is a market. During the financial crisis, prices were quoted, but there was no (or little) trade at such prices.
reduce the quantity of trade to recover information insensitivity. The risk is that the debt becomes information sensitive, in which case most agents may not know the true default risk. Dang, Gorton & Holmström (2018) show that information sensitivity is not rank-correlated with variance and skewness of a security. A security with low variance can have higher information sensitivity than a security with higher variance.

2.3. Theoretical Implications and Qualitative Evidence

Dang, Gorton & Holmström’s (2018) paper is about primary markets for short-term debt, debt that is typically overnight or a few days. Because of the short maturity it is possible to change the terms of the contract quickly. Agents, in the face of bad public news (e.g., declining house prices) correlated with collateral value, can try to maintain the information insensitivity of debt. There are five ways to do so: (a) reduce quantity and lower the face value of the debt, (b) add collateral, (c) reduce the riskiness of the collateral, (d) increase the haircut, and (e) shorten the maturity. Figure 4 shows the increase in haircuts on an equal-weighted index of haircuts of 10 structured products, such as MBS and ABS, that were used as collateral for repo. Maturities also decreased. Figure 5 shows the dramatic shortening of dealer banks’ positions after the Lehman Brothers failure. Similarly, Figure 6 (Gorton, Metrick & Xie 2015) plots the London interbank offered rate (LIBOR) minus the overnight index swap (OIS) 3-month spread and the short–long issuance ratio for AA ABCP. The ratio is defined as the ratio of the amount of CP issued with a maturity of less than 20 days (over a 30-day window) divided by the amount of CP issued with a maturity of 20 days or more (over a 30-day window). The LIBOR minus OIS is a measure of bank counterparty risk. The figure shows that as this measure rises, maturities of CP shorten.

If there is a crisis, quantities adjust to zero: No one wants the short-term bank debt; they want cash. Such a switch is a financial crisis. Such a switch has historically occurred with many
Lehman Brothers collapse

Figure 5
Dealers’ overnight securities as a percentage of the total (difference between securities out and securities in). Data from Primary Government Securities Dealers Reports (form FR2004), form C.

Figure 6
Counterparty risk (basis points) and CP maturities. This figure plots the LIBOR minus OIS 3-month spread and the short–long issuance ratio for AA ABCP. The ratio is defined as the ratio of the amount of CP issued with a maturity of less than 20 days (over a 30-day window) divided by the amount of CP issued with a maturity of 20 days or more (over a 30-day window). Abbreviations: ABCP, asset-backed CP; CP, commercial paper; LIBOR, London interbank offered rate; OIS, overnight index swap. Figure adapted with permission from Gorton, Metrick & Xie (2015).
different forms of short-term debt: banknotes, demand deposits, sale and repurchase agreements, various forms of CP, certificates of deposit (CDs), and money market funds (MMFs). In each case the switch occurs when the value of the underlying collateral is questioned (see Gorton 2018). Figure 7 shows the outstanding amounts of ABCP and financial firms’ CP. ABCP decreased from $1.2 trillion to about $420 billion in a short period of time (see also Covitz, Liang & Suarez 2013).

To prevent a switch from an information-insensitive to an information-sensitive state, quantities adjust, as with haircuts on the backing collateral rising in the case of repo. Sometimes there is information production that leads to so-called dry-ups, when some banks cannot get funding but others can. On occasion the information acquisition is done by sophisticated investors, leaving the unsophisticated behind. Sometimes maturity is shortened to try to maintain information insensitivity. A financial crisis occurs when short-term debt becomes information sensitive and quantities go to zero, as in the recent financial crisis. Bilateral repo essentially went to zero (see Gorton & Metrick 2012).

The Federal Reserve Bank’s response to the crisis is also instructive and provides further evidence. Rather than implement transparency, the Fed did the opposite. Emergency lending programs were put into place, and these programs were designed to make loans in secret, protecting the anonymity of borrowers in order to avoid identifying weak banks, which might then face runs. Borrowers become stigmatized if their names are revealed. Also, in an attempt to prevent revelation of weak financial institutions, the Securities and Exchange Commission (SEC) instituted short-sale bans on the stock of 797 financial firms starting on September 18, 2008.

The idea of reducing information in a financial crisis has a long history. In the USA prior to the existence of the Federal Reserve, private bank clearinghouses responded to financial crises by cutting off information. Member banks were prohibited by the private bank clearinghouse from publishing their financial information in the papers, which in normal times they were required to do. The clearinghouse operated an internal discount window, but the identities of borrowing banks were kept secret (see Gorton & Tallman 2018). The response of private bank clearinghouses and central banks to crises has been to make markets in the collateral for which there is no market,
which involves reducing transparency in order to go back to a system of information insensitivity. Reducing transparency is a way to try to recreate opacity so that short-term debt can maintain information insensitivity (see Gorton & Ordoñez 2020). Following the US bank holiday declared by President Franklin D. Roosevelt in 1933, New York state bank regulators suspended publication of state banks’ balance sheets, but national bank regulators did not. Anderson & Copeland (2019) compare the different responses to these two policies and show that state banks had deposit increases, not withdrawals.

In noncrisis times, in order to prevent information production about their assets, banks are opaque (Dang et al. 2017).³ Deposit insurance makes the backing collateral for demand deposits the government’s taxing power; it will not be profitable for depositors to produce information. Still today, even with deposit insurance, banks are opaque. Badertscher, Burke & Easton (2018) examine the stock price reactions to the quarterly release of bank call reports, which contain information that banks have self-reported to regulators. They find significant and large stock price reactions of banks upon release of the information, even if the call reports are released following the quarterly bank earnings announcements. Mean price volatility and volume are also elevated on release dates.

Bank examiners also produce information, which is kept confidential. DeYoung et al. (2001) find that this information is informative and is eventually revealed in bank subordinated debt prices (see also Berger & Davies 1998).

2.4. Summary

Money market instruments are opaque by design. Debt backed by debt collateral is the optimal design to make the short-term debt information insensitive. There is no price discovery and no costly information gathering about payoffs, and everyone knows this. Consequently, the price of money market instruments does not change. In fact, raising the interest rate does not compensate for the risk of the instrument becoming information sensitive. That is a different risk from default risk.

The fact that the price of a money market instrument is not supposed to change means that the margin for adjustment is quantities (and maturity). A financial crisis occurs when information-insensitive debt becomes information sensitive. Questions are asked about the backing collateral, and since no one knows how to price the information-sensitive collateral, there are no prices.

A main message from Dang, Gorton & Holmström (2018) is that money markets are fundamentally different from equity markets. Money market instruments are information insensitive. There is only a primary market for such instruments. Equity is information sensitive and trades in a secondary market. And these differences explain much about the infrastructure surrounding these two categories of assets. Table 1 lists the characteristics of information-insensitive money market securities and information-sensitive equity securities. A look down one of the columns reveals that the characteristics of each system are consistent. But a look across the rows makes it clear that the two systems are polar opposites.

3. EMPIRICAL EVIDENCE

In this section we review some of the more important papers that provide evidence about information sensitivity, nonprice adjustments when bad public news arrives, and the harmful effects of transparency in a variety of contexts.

³In the USA, banknote discounts revealed information. But when private banknotes were replaced by national banknotes and demand deposits, banks endogenously became opaque (see Gorton 2015). Later, deposit insurance made demand deposits information insensitive.
Table 1  System characteristics of opposite systems of liquidity

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<th>Stock markets</th>
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<td>No price discovery</td>
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<td>Cheap, stable liquidity</td>
<td>Expensive, risky liquidity</td>
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Table based on Holmström (2015).

3.1. The Switch from Information Insensitive to Information Sensitive and Information Production

New public information about the fundamental value of collateral can change the information sensitivity of securities. The transition from information insensitive to information sensitive can result in information being produced and informed investors acting on their private information. Gallagher et al. (2020) and Brancati & Macchiavelli (2019) provide empirical evidence for this view.

One setting in which information was produced at the start of a crisis is MMFs at the onset of and during the Eurozone crisis of 2011–2012. MMF shares are a form of short-term quasi-debt that is treated as information-insensitive debt by fund shareholders, although technically it is not debt. During noncrisis times, these instruments are essentially priced at par; they are information insensitive. Gallagher et al. (2020) study investor information production, MMF redemptions, and MMF managers’ rebalancing decisions during the Eurozone crisis. They find that there was significant selective information acquisition and that, although there were redemptions at all funds, the reductions were largest for funds with the most sophisticated investors, who did produce information: “Under these circumstances, MMF shares become information-sensitive because MMF’s risk exposures are suddenly differentiated following the acquisition of information” (Gallagher et al. 2020, p. 1445).

At the start of the Eurozone crisis, bad news about the exposures of European banks to a potential default of some European debt came out. Not all agents have the same cost of producing information. Thus, more sophisticated investors (institutions) produced information and made redemptions at the MMFs that had higher exposure to information-sensitive European bond issuers. As a result, money managers adjusted their portfolios to “avoid information-sensitive European risks” (Gallagher et al. 2020, p. 1445), that is, to keep their funds information insensitive.

Using proprietary data from the Investment Company Institute, Gallagher et al. (2020) created the variable SOPH (short for sophisticated investors). SOPH is the fraction of a fund which is held by institutional investors. From this measure three categories of sophistication are created: HiSOPH, which is 82% institutions, and MidSOPH and LoSOPH, among which the remaining funds are split.

Gallagher et al. (2020) measure information production by the number of page views the different categories of investors conducted with regard to fund filings on the SEC’s EDGAR website. Figure 8 shows the results for the three categories of investors: HiSOPH, MidSOPH, and LoSOPH. Note that the axis for the Lo- and MidSOPH groups is different from that for HiSOPH. The figure shows the dramatic increase in visits to the SEC website around the start of the Eurozone crisis: “Our measure of investor information acquisition from the SEC EDGAR
website . . points to little information prior to June 2011, followed by a substantial increase in information acquisition during the crisis. This increase occurred almost exclusively among funds with a high concentration of sophisticated investors” (Gallagher et al. 2020, p. 1447).

Importantly, there is no price discovery with MMFs. The sophisticated investors produce information, but this is not observed by the less sophisticated, who remain uninformed. The sophisticated withdraw from the MMFs, but this is unobserved by the other investors. The uninformed do not withdraw.

The sophisticated investors act on their information. Funds with relatively more-sophisticated investors experienced relatively higher outflows amounting to about 10% of aggregate assets from early June to early July 2011. Gallagher et al. (2020) also show that the selective information acquisition by sophisticated investors led to responses by the fund managers, who attempted to recover information insensitivity by rebalancing their portfolios. Fund managers sold securities that had become particularly information sensitive, for example, uncollateralized debt from French/Belgian financial issuers like BNP Paribas or Dexia. Furthermore, fund managers shortened maturities dramatically.

According to Dang, Gorton & Holmström (2018), a financial crisis is a shift from information-insensitive to information-sensitive short-term debt. Brancati & Macchiavelli (2019, p. 100) examine the Panic of 2007–2008 and “provide direct evidence that while in good times bank debt is largely informationally insensitive, it becomes significantly sensitive to information in bad times.” These authors essentially show that in noncrisis times, when the economy is to the right of the kink in Figure 3, there is no information produced. But near the kink or to the left of the kink, information is produced.

Brancati & Macchiavelli (2019) have two main results. First, they find that precise information amplifies the sensitivity of default risk to market expectations: Pessimistic expectations have a larger effect on default risk (measured by CDS spreads) the more precise the information is. Precise information (measured by the dispersion of analysts’ forecasts) also has a direct and negative impact on default risk. Precrisis, these effects are not at work, suggesting that bank debt is

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**Figure 8**

informationally insensitive in good times. Second, they find that more information is produced at the onset of the crisis. More analysts are assigned to cover banks, and the analysts produce significantly more precise information, measured by the standard deviation of banks’ returns on assets (ROA).

Brancati & Macchiavelli (2019) focus on banks’ CDS spreads and the relations between median analysts’ forecasts of banks’ ROA and the dispersion of those forecasts. A reduction in the standard deviation of analysts’ forecasts is interpreted as an increase in the precision of information. Brancati & Macchiavelli (2019) interact the precision of the information with the ROA forecasts to see whether more precise information has a larger impact on CDS spreads. This is termed the information multiplier. In addition, they look at whether more precise information has a larger impact on banks that are expected to do poorly, those banks with a bad ROA forecast. Furthermore, they examine this effect on banks with a bad ROA forecast over the period January 2004–December 2012 to understand whether the effects on CDS spreads are amplified during the crisis.

Their benchmark specification is as follows:

\[
\text{CDS}_{it} = \rho \text{CDS}_{it-1} + \gamma_1 E_t (\text{ROA}_{i,t+1Y}) + \gamma_2 E_t (\text{ROA}_{i,t+1Y}) \text{Precise}_{it} + \gamma_3 E_t (\text{ROA}_{i,t+1Y}) \text{Imprecise}_{it} \\
+ \gamma_4 \text{Disp}_{it} \text{Bad}_{it} + \gamma_5 \text{Disp}_{it} \text{Good}_{it} + \beta^T \xi_{it-1} + \eta_t + \lambda_t + \epsilon_{it},
\]

where Precise\(_{it}\) is an indicator function specifying when information is precise, which means that the standard deviation of analysts’ individual forecasts about bank \(i\) at time \(t\) is below the median of its cross-sectional distribution. Imprecise\(_{it}\) is the complement of Precise\(_{it}\). Disp\(_{it}\) is the standard deviation of analysts’ forecasts formed at time \(t\) about the one-fiscal-year-ahead ROA (indicated by the subscript 1Y\(^t\)). Bad\(_{it}\) is a dummy variable indication that expectations in month \(t\) about bank \(i\) are in the bottom quartile (or decile) of its monthly cross-section distribution. Good\(_{it}\) is the complement of Bad\(_{it}\). \(\xi_{it-1}\) is a vector of controls. Finally, there are bank and time fixed effects.

The specification allows Brancati & Macchiavelli (2019) to study whether more precise information amplifies the reaction of CDS spreads to expected future bank profitability during a crisis in comparison to normal times. Is it the case that \(|\gamma_2| > |\gamma_3|\)? They find that in a crisis more precise information amplifies market expectations of default risk, and that more precise information increases default risk for banks that are expected to perform poorly. These effects are not present in noncrisis times.

Brancati & Macchiavelli (2019) also ask whether more information is produced at the onset of a crisis, to distinguish good banks from bad banks. They estimate a panel of banks in which the dependent variables are the dispersion of analyst forecasts or the number of analysts assigned to cover each bank. At the onset of the crisis, more analysts are assigned to cover banks and there is a significant decrease in the dispersion of analyst forecasts. That is, more resources are devoted to information production, and more information is produced.

### 3.2. Nonprice Adjustments

That quantity adjustments sometimes result in the quantity going to zero, rather than the price adjusting, is most easily seen in the recent financial crisis. As noted above, in Figure 6, ABCP and bilateral repo decreased significantly (see Covitz, Liang & Suarez 2013; Gorton & Metrick 2012). But other margins may also adjust. In this subsection we look at evidence consistent with this idea.

Pérignon, Thesmar & Vuillemey (2018) study the wholesale CD market in Europe during 2008–2014. They argue that the switch from information-insensitive to information-sensitive debt should occur when there is the arrival of bad public news: “We show that ratings downgrades can be such public news; [CD] issuance drops significantly for issuers facing downgrades. Along the
same lines, we also find that dry-ups typically occur after drops in stock prices” (p. 579). But their basic finding is that there was not an all-out run; rather, information appears to have been produced, and lenders discriminated between good and bad banks: “Importantly, the CD market did not experience any global freeze and dry-ups did not have a strong aggregate component. . . . We then show that banks experiencing [funding] dry-ups are those whose performance is set to decrease in the future, controlling for current performance” (p. 577).4

CD issuing banks attempted to maintain the information insensitivity of their CDs. Issuers facing a dry-up decreased the maturity of new CDs in the several months before the decline in their CD volume. Pérignon, Thesmar & Vuillemey (2018) also show that there was not much of an increase in CD rates, differentiating the risk of different banks “suggesting that risk is not priced on a bank-by-bank basis” and that “[t]hese results are consistent with the idea that prices are not the main variable used to clear the CD market” (p. 578). The dry-ups experienced by some banks were due to sophisticated investors becoming informed and cutting lending to weak banks, that is, adjusting the quantity. “Overall,” they write, “these results. . . suggest that adjustments in the CD market occur primarily through quantities rather than prices” (p. 606).

If short-term bank debt is information insensitive, then the exchange rate of the debt with cash is one to one, and since the price of the bank debt does not change, the quantities adjust. This should be true in crises but also in normal times. Gorton (1988) examines a Baumol–Tobin money demand equation in which there is a cash-in-advance constraint. The cash in advance is a reduced form for Gorton & Pennacchi (1990). Gorton (1988) shows that the currency–deposit ratio is determined by an Euler equation, as in asset pricing, but in this case the stochastic discount factor interacts with the expected return on the debt. In standard asset pricing, the Euler equation is used to price assets on the basis of the intertemporal terms of trade (the stochastic discount factor). Asset prices change on the basis of the stochastic discount factor, but when the prices of cash and bank debt are constant, the exchange rate is fixed at one to one. Asset prices do not change, so the Euler equation shows how the quantities change depending on the interaction of the stochastic discount factor and the expected return on the bank debt. The quantity adjustment fits naturally into the standard Euler equation framework when the price of privately produced debt is information insensitive.

Gorton (1988) examines the US National Banking Era (1863–1914), a period with five major banking panics. He estimates the money demand model described above and shows that the model not only describes quantity adjustments during normal times but also explains banking panics based on changing information. Empirically, in the Euler equation framework, when agents received unexpected information about coming recessions, and this shock was above a threshold, there was a panic. There was never a panic without the information shock exceeding the threshold, and the threshold was never exceeded without a panic occurring. This finding is consistent with Dang, Gorton & Holmström’s (2018) model, in which the switch from information insensitive to information sensitive occurs upon receipt of sufficiently bad news. Normal times and panics are described by the quantity adjustment model.

3.3. Transparency

Opacity is a desirable feature of money market instruments. The private banknotes that circulated as money during the pre–Civil War era were not efficient forms of money because they

4Pérignon, Thesmar & Vuillemey (2018) define a full dry-up as a case where the bank’s CD issuance ceases. A partial dry-up is a case where issuance drops by 50% or more. Brancati & Macchiavelli (2020) show that funding dry-ups in the USA are preceded by maturity shortening.
were information sensitive. In the modern era, MMFs have been an efficient form of money because the implicit contract defining MMFs was that they would not “break the buck” but rather maintain the one-to-one ratio of an MMF share and cash. This feature allowed MMFs to effectively compete with demand deposits. But following the Lehman Brothers failure there was a run on MMFs. The surprising regulatory response to this run was to eliminate MMF moneyness (information insensitivity).

In 2014 the SEC introduced MMF reforms, which resulted in outflows from prime MMFs exceeding $1 trillion because these funds lost their moneyness. They became information sensitive. There were no effects on government MMFs. The share of government MMFs increased from 33% to 76%. The effects of these reforms have been studied by Baghai, Giannetti & Jäger (2018) and Cipriani & La Spada (2018).

Baghai, Giannetti & Jäger (2018) analyze the effects of the new postcrisis US money market regulations on the moneyness of MMFs. In particular, under the new rules, institutional MMFs must reveal their net asset value regularly. In other words, the new regulations sought to ensure transparency. These funds can no longer maintain their opacity. Thus, MMFs are no longer money-like. The authors show that (a) MMFs lose their money-like quality and (b) since MMFs are no longer money-like, the MMF managers change their behavior, making their funds riskier so as to offer higher rates to maintain demand. In contrast, Pérignon, Thesmar & Vuillemey (2018) and Gallagher et al. (2020) find that managers take steps to undo the shock to maintain information insensitivity.

To show that the moneyness of these funds decreased, the authors demonstrate that assets under management were no longer correlated with proxies for money demand; for instance, they were no longer negatively correlated with the 4-week spread of Treasury bills (T-bills) over the OIS rate. In so doing, Baghai, Giannetti & Jäger (2018) follow Sunderam (2015) and estimate the following type of equation:

$$\ln(\text{total net assets})_t = \alpha + \beta(\text{T-bill} - \text{OIS})_t + \epsilon_t.$$  

The T-bill–OIS spread is a measure of money demand; it measures the convenience yield. T-bills are a riskless cash instrument, while OIS is a riskless derivative. Sunderam focused on showing that more ABCP was issued precrisis when the convenience declined; in other words, with a greater demand for T-bills, its yield would fall relative to OIS. Therefore, the correlation is negative. With respect to MMFs, Baghai, Giannetti & Jäger (2018, p. 3) show that, following the announcement of the money market reforms, the correlation became positive, suggesting that MMFs’ liabilities were no longer considered money-like: “[W]e find that the aggregate net assets under management of MMFs are no longer negatively associated with the spread of four-week Treasury bills over the four-week overnight indexed swap (OIS) rate, which is typically thought to be low when the demand for money-like securities is high.” There was also an adjustment of quantity. Many prime MMFs exited the industry or changed into government MMFs, which are not affected by the change in regulation.

In general, investors in mutual funds are sensitive to performance, with inflow following good performance and vice versa. Postreform MMFs are no longer money-like, so they may then be concerned about this sensitivity of flows to performance, like information-sensitive mutual funds. Indeed, Baghai, Giannetti & Jäger (2018) find that, postreform, the remaining MMFs increased the portion of their portfolio holding riskier assets. Also, MMFs became more sensitive to their performance, and “[i]mportantly, the increase in flow-performance sensitivity is particularly pronounced for MMFs that sell predominantly to institutional investors” (p. 4).

Cipriani & La Spada (2018) also study the effects of the 2014 SEC money market reforms. They compare the response of MMF investors to the 2014 regulatory change with past episodes
of industry dislocation, in particular, the MMF run following the Lehman Brothers collapse in 2008. Also, the 2014 rules affected institutional investors and retail investors differently. Both types of funds were required to install liquidity fees and redemption gates, but only institutional funds were required to switch to a floating net asset valuation. These differences allow the authors to examine an empirical design (differences-in-differences) that uses these differences.

Cipriani & La Spada (2018) examine the net yield spread between prime and government funds in a differences-in-differences design and estimate the premium for moneyness to be 20 basis points for retail investors and 28 basis points for institutional investors (who were affected more by the regulations). They also estimate that before the reform prime and government funds were close substitutes, but the reform caused the elasticity of substitution between the two types of funds to drop from 0.50 to 0.11. In other words, postreform, the two types of funds were viewed as different: “This decrease confirms that, whereas before the regulation prime and government MMFs were perceived as very similar financial products, such similarity disappeared once shares in prime MMFs became information sensitive and therefore ceased to be perceived as money-like assets” (p. 3).

The Dang, Gorton & Holmström (2018) debt-on-debt structure also says that the collateral backing the short-term debt is also debt, and this debt should be information insensitive. In these authors’ model, the backing collateral can be tranched so that the senior tranche is the collateral, which has the junior tranche as a buffer against losses. Because of the junior equity–like piece, the short-term debt backed by the senior tranche can be information sensitive. This is the logic of securitization (see, e.g., Stenzel 2013). Securitization grew because of a need for high-quality debt that could be used as collateral. Prior to the financial crisis, the debt frequently used to back repo and ABCP was ABS and MBS. ABS and MBS are bonds that are backed by portfolios of loans. ABS and MBS are designed to achieve both goals, low information sensitivity and high costs of producing information.

Securitization illustrates that, for the construction of information-insensitive debt, tranching is superior to slicing; in other words, a junior–senior structure is best. Securitization results in bonds with different ratings, all investment grade. The residual tranche (equity) does not trade, so no information is revealed. The AAA/Aaa tranches of ABS/MBS were viewed as safe debt. Xie (2012) finds that, on average, 86.3% of an ABS/MBS deal was rated AAA. Although viewed as safe, during the financial crisis the quantities of ABS and MBS also changed: Issuance dropped dramatically. This situation is shown in Figure 9, where, again, the quantities adjusted.

In the aftermath of the Panic of 2007–2008, there were many calls for more transparency with regard to MBS. Such transparency could destroy the information insensitivity of the AAA/Aaa tranches used as collateral. This issue was examined by Balakrishnan, Ertan & Lee (2019), who empirically analyzed the European Central Bank’s loan-level disclosure program (ECB LLD), implemented in January 2013. The ECB LLD established specific information requirements for ABS and MBS that were accepted as collateral by the ECB. The rules require monthly or quarterly disclosures of specified details of the underlying loans that were securitized. Balakrishnan, Ertan & Lee (2019) focus on MBS. The sample is 56,377 security-months based on 1,930 tranches from 12 European countries. The price data, from Bloomberg, consist of marks provided by dealer banks.

The goal of the ECD LLD initiative was to create transparency. However, Balakrishnan, Ertan & Lee (2019) show that this public loan-by-loan disclosure resulted in reduced liquidity for senior tranches by 7.9% and increased liquidity for the information-sensitive risky tranches by 5.0%.

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5Gorton & Metrick (2013) provide a survey of the literature on securitization (see also Gorton & Souleles 2006).
(supersenior tranches were not affected). That is, the information-insensitive senior tranches lost liquidity, whereas the information-sensitive tranches became more liquid. This is consistent with the junior tranches being information sensitive and the senior tranches, which were information insensitive, becoming sensitive.

Balakrishnan, Ertan & Lee (2019) also look at these liquidity effects across the dimension of investor sophistication. The ECB LLD disclosures provide data, but still a level of sophistication is required to make use of these data. The authors measure the degree of sophistication by the standard deviation across the number of distinct MBS deals that an investor invested in, calculated pre-regulation: “[W]e find that enhanced disclosures do not impair liquidity for MBSs of which investors are similar to one another in terms of skill and expertise in processing disclosed information (our empirical proxies for investor sophistication). In contrast there is a 15.3% increase in illiquidity for cases with greater disparity in investor sophistication” (p. 5). In summary, these regulatory responses to the financial crisis backfired.

3.4. Summary
The papers described above have drawn implications of Dang, Gorton & Holmström’s (2018) model and gone beyond. Dang, Gorton & Holmström (2018) say nothing about sophisticated and unsophisticated investors, nor about dry-ups. The empirical research is consistent with their implications.

4. CORPORATE AND MUNICIPAL BONDS
Dang, Gorton & Holmström’s (2013) paper is about short-term debt, although the debt collateral backing it may be long-term debt, such as AAA/Aaa ABS or MBS (or Treasuries). The short-term

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6 Liquidity is the number of trading days without a trade divided by the total number of trading days in a month.
debt market is only a primary market because the maturities are short. Short-term debt can be restructured (e.g., by a change in the haircut or maturity) easily if it is rolled over. Corporate bonds are longer maturity than money market instruments. Holders have no way to introduce a haircut or to shorten the maturity. The bond can be sold, but there is no way to turn a bond into cash prior to maturity. Longer-term bonds trade over the counter but, in fact, rarely trade. Figure 10 shows the percentage of the outstanding amount of US corporate bonds that trade each year, less than 50 basis points per year7 (see also Mizrach 2015). Nevertheless, all securities have the property of information sensitivity. But we do not expect corporate bonds to be fully information insensitive, except perhaps for those that are AAA/Aaa.

There are large quantity adjustments with bond issuance, however. While the bonds outstanding cannot change, issuance can shrink. Bond issuance shrunk significantly during the panics of 1884, 1893, and 1907 and the Great Depression (Benmelech & Bergman 2018b; Benmelech, Frydman & Papanikolaou 2019). Similarly, during the Panic of 2007–2008 the issuance of securitization shrank significantly, as shown in Figure 9.

Researchers have investigated implications of information sensitivity for corporate and municipal bonds. In the following subsections we summarize their work.

4.1. Corporate Bonds and Information Sensitivity

Corporate debt does have some characteristics of information insensitivity. For example, according to Best (2015, p. 9), most new investment-grade bond issues are announced and sold the same day: “New-issue order books can close as soon as 15 minutes after the transaction announcement, while some may stay open for several hours. The average tends to be in the 1–2 hour range.” There is little due diligence: “From the time issues are announced (usually early to mid-morning New York time), investors generally have a short period to analyze the issue, review covenant protections, and decide if they are comfortable participating at indicated price guidance” (p. 9).

---

7The data for dollar volume of US corporate bonds traded start in 2002 because in July 2002 the SEC-mandated TRACE (Trade Reporting and Compliance Engine) system was initiated, requiring mandatory reporting of over-the-counter secondary market trades in bonds (see http://www.finra.org/industry/trace).
Equity is different. Initial public offering underwriting books must be built over time, and initial public offerings are underpriced. Rock (1986) studies a new issue equity market model in which there are some informed agents and some uninformed agents. If new shares are priced at the expected value (conditional on public information), then the informed agents will buy when the true value (based on their private information) is greater than the expected value, and they will not buy if the true value is below the expected value. Rock (1986) shows that the price of the shares must be set at a discount to entice the uninformed to participate. This discount or haircut creates an excess demand for shares, so that rationing occurs. As a result, weighting the returns by the probability of obtaining an allocation delivers a rate of return to the uninformed that is immune from adverse selection. But when the stock is issued and is trading on an exchange, analysts follow the company, and the price is efficient. Consequently, new seasoned equity offerings (offerings by firms that already have issued stock in the past) do not display any discount to the market price (see Loderer, Sheehan & Kadlec 1991).

Bonds have ratings; equity is not rated. Bond ratings indicate distance from the kink (see Figure 3). But ratings are very coarse. They certainly are not fine enough to be useful for assessing risk. Coarse ratings result in buckets of equivalent collateral, collateral rated AAA/Aaa, for example. In this way beliefs are coordinated. Coarse ratings promote “commonality of beliefs,” in the language of Morris & Shin (2007), who show that such commonality is desirable because it reduces problems of adverse selection.

Are corporate bonds information insensitive or sensitive? Kwan (1996) studies the correlations between individual firms’ changes in their bond yields and the firms’ own stock returns. Kwan estimates the following empirical specification:

\[
\Delta Y_{jt} = \beta_0 + \beta_1 \Delta T_{jt} + \beta_2 R_{jt+1} + \beta_3 R_{jt} + \beta_4 R_{jt-1} + \epsilon_{jt},
\]

where \( \Delta Y_{jt} \) is the change in bond \( j \)'s yield to maturity from \( t-1 \) to \( t \); \( \Delta T_{jt} \) is the change in a similar-maturity US Treasury bond yield from \( t-1 \) to \( t \); \( R_{jt} \) is the return on bond \( j \)'s issuing firm's stock from \( t-1 \) to \( t \), and so on; and \( \epsilon_{jt} \) is the error term. The specification includes a lag of stock returns and a future return, in addition to the current return. The \( \beta \) coefficients could be either positive or negative, depending on the type of information about future stock returns, specifically, the mean or variance of the distribution of firm fundamentals. The key question is whether there is any relation between the change in bond yields and (future, current, or lagged) stock returns of the same firm’s equity. Is the change in bond yield purely driven by own-firm news about fundamentals, captured by its own stock returns, or by discounting, changing mostly when the term structure of Treasury returns changes?

If the information contained in stock returns is, on average, about changes in the mean of expected future cash flows, then bad news, namely low stock returns, should be negatively correlated with the change in the firm’s own bond yields. Stock returns go down, so bond yields go up. Table 2 shows Kwan’s results by rating category.8 We observe that AAA bond yield changes are driven by Treasury yield changes only. There is no relation with information in the firm’s own stock returns. AAA bonds are information insensitive. AA bonds are a bit less sensitive to Treasury yield changes, and a bit more sensitive to own-stock returns. A-rated and BBB-rated bonds follow suit, with the differences between bond ratings monotonic: less sensitive to Treasury yield changes as the rating drops and more sensitive to own-stock returns as the rating drops. Finally, note that bonds below investment grade are information sensitive. The change in BB bond yields is not

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8Return data were not available because coupon dates for the bonds were not available.
9The bond data are from Merrill Lynch. Weekly closing bid yields were calculated from the price of the last transaction.
Table 2  Individual firm bond yield changes and own-stock return correlations

<table>
<thead>
<tr>
<th>Variable</th>
<th>AAA</th>
<th>AA</th>
<th>A</th>
<th>BBB</th>
<th>BB</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta T_{j,t}$</td>
<td>0.5987$^a$</td>
<td>0.5513$^a$</td>
<td>0.5371$^a$</td>
<td>0.4923$^a$</td>
<td>−0.0506</td>
<td>−0.008</td>
</tr>
<tr>
<td>$R_{j,t+1}$</td>
<td>0.2173</td>
<td>0.0370</td>
<td>0.0551</td>
<td>0.0290</td>
<td>−0.2296$^a$</td>
<td>−0.0839</td>
</tr>
<tr>
<td>$R_{j,t}$</td>
<td>−0.1963</td>
<td>−0.0878$^b$</td>
<td>−0.1033$^a$</td>
<td>−0.3489</td>
<td>−0.5011$^a$</td>
<td>−0.4079$^a$</td>
</tr>
<tr>
<td>$R_{j,t-1}$</td>
<td>−0.2015</td>
<td>−0.1981$^a$</td>
<td>−0.2483$^a$</td>
<td>−0.3313</td>
<td>−0.3309$^a$</td>
<td>−0.1656$^a$</td>
</tr>
<tr>
<td>$N$</td>
<td>672</td>
<td>11,605</td>
<td>17,289</td>
<td>10,127</td>
<td>2,344</td>
<td>1,331</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.61</td>
<td>0.50</td>
<td>0.41</td>
<td>0.40</td>
<td>0.04</td>
<td></td>
</tr>
</tbody>
</table>

$^a$Significance at the 0.1% level.
$^b$Significance at the 1% level.

Abbreviations: $R_{j,t}$, the return on bond j’s issuing firm’s stock from $t − 1$ to $t$, and so on; $\Delta T_{j,t}$, the change in a similar maturity US Treasury bond yield from $t − 1$ to $t$.

Table adapted from Kwan (1996).

related to the change in Treasury yields. They are correlated only with own-stock returns. Junk bonds are fundamentally different from investment-grade bonds (see Gorton & Metrick 2010). Junk bonds’ fundamentals put their value near the kink, and in fact junk bonds typically trade on the NASDAQ stock exchange. Schaefer & Strebulaev (2008) show similar results.

Thus, corporate bonds appear to have degrees of information sensitivity. But they are information insensitive enough to trade over the counter rather than on a centralized exchange. And the evidence of information insensitivity is more visible with respect to how they are priced once issued. The prices of corporate bonds and of ABS and MBS are somewhat constant. Corporate bonds and structured bonds are priced for purposes of marking portfolios to market by matrix pricing. That is, the price is an estimate or guess, since these instruments do not trade very often. Typically, matrix pricing is done by tying the bond yield to a benchmark bond index by a spread in basis points determined by the dealer bank. As a result, there is no single price of a bond.

Since bonds are infrequently traded over the counter, there is no price discovery—the price is not an aggregation of many agents’ information and cannot be seen in any central place. So, how hard is it to mark them to market? Cici, Gibson & Merrick (2011) look at the dispersion of month-end valuations placed on identical bonds held by different bond mutual funds. The marks differ. This is not surprising, since the prices to mark the bonds are supplied by dealers using different matrix prices. Table 3 reproduces some of these authors’ results. The table shows the interquartile range based on the price per $100 face. An interquartile range of 0.364 means, for example, that prices run between 96.00 and 96.364. The fact that debt instruments are traded over the counter, and that the price of any single bond can vary, is consistent with the idea that liquidity in those markets is based on information insensitivity.

4.2. Information Production About Corporate Bonds

When is it profitable to produce information about corporate bonds? Dang, Gorton & Holmström (2018) predict that the closer the collateral value backing the debt is to the kink of the hockey stick

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$^{10}$The Bloomberg Barclays US Aggregate Bond Index is the leading example of such an index. Bonds in the index are weighted by the size of the issue. Most investment-grade bonds are included. The average maturity is around 5 years.
Table 3  Bond price dispersion

<table>
<thead>
<tr>
<th>Credit rating</th>
<th>Price dispersion</th>
<th>Number of observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA</td>
<td>0.228</td>
<td>4,211</td>
</tr>
<tr>
<td>AA</td>
<td>0.255</td>
<td>10,874</td>
</tr>
<tr>
<td>A</td>
<td>0.281</td>
<td>59,612</td>
</tr>
<tr>
<td>BBB</td>
<td>0.332</td>
<td>73,847</td>
</tr>
<tr>
<td>BB</td>
<td>0.542</td>
<td>32,831</td>
</tr>
<tr>
<td>B</td>
<td>0.554</td>
<td>46,754</td>
</tr>
<tr>
<td>CCC</td>
<td>0.604</td>
<td>11,350</td>
</tr>
<tr>
<td>CC</td>
<td>0.679</td>
<td>911</td>
</tr>
<tr>
<td>C</td>
<td>0.712</td>
<td>620</td>
</tr>
<tr>
<td>D</td>
<td>0.571</td>
<td>3,674</td>
</tr>
<tr>
<td>Investment grade</td>
<td>0.303</td>
<td>148,544</td>
</tr>
<tr>
<td>High yield</td>
<td>0.559</td>
<td>96,140</td>
</tr>
</tbody>
</table>

*The table reports dispersion measures for bonds that are held by at least three mutual funds on the same date. Price dispersion is measured by the interquartile range of reported prices.

Table adapted from Cici, Gibson & Merrick (2011, table 6).

(Figure 3), the more valuable information becomes and the more information will be produced. This is, indeed, the case for corporate bonds. Johnston, Markov & Ramnath (2009) study 5,920 debt reports produced by sell-side debt analysts from 15 brokerage firms that cover 822 companies. The sample period is 1999–2004. They find that “the amount of resources devoted to debt research depends on the debt’s price sensitivity to information about the value of the asset. Intuitively, the sensitivity of the price of debt determines how much one can profit from information about the company’s assets in the debt market” (p. 92)—in other words, the $\pi$ discussed above. The number of debt analysts’ reports monotonically increases in the 120 days prior to a rating downgrade. Johnston, Markov & Ramnath (2009) find no similar pattern with respect to imminent rating upgrades (moving away from the kink). Furthermore, the authors “do not observe any debt reports for most company-years” (p. 99). In contrast to the debt coverage, equity coverage decreases with a higher probability of firm default (p. 101), that is, near the kink. As the firm value nears the kink, the debt increasingly becomes the firm’s equity.

So far, the empirical evidence is consistent with corporate debt being information insensitive to some degree. Is there evidence consistent with Johnston, Markov & Ramnath’s (2009) finding that more information is produced when a bond’s fundamentals deteriorate (as measured by ratings in the Johnston et al. case)? Whatever the degree of information insensitivity, Benmelech & Bergman (2018a) examine corporate bonds and provide evidence for the relationship between information and liquidity. If the perceived value of the underlying fundamentals of debt is high so that it is agreed that the bond value is on the flat portion of the hockey stick to the right, it is information insensitive. But if the fundamentals backing the bond deteriorate, then the debt starts to near the kink and becomes (more) information sensitive and less liquid. This is what Benmelech & Bergman (2018a) examine.

They focus on corporate bonds that recently dropped in price, cases in which the fundamentals have arguably deteriorated (see also Benmelech & Bergman 2018b). They show a negative and nonlinear relation between measures of illiquidity and bond price. The nonlinearity is the
When the price drops, the bond becomes less liquid. They measure liquidity with the three standard measures in the literature.11

Their basic estimation equation is

\[
\text{Illiquidity}_{it} = \alpha + \beta_1 \times \text{YieldSpread}_{i,t-1} + \beta_2 \times X_{i,t-1} + \theta_i + \delta_t + \epsilon_{it},
\]

where Illiquidity is one of the three liquidity measures; YieldSpread\(_{i,t-1}\) is the bond yield spread over a maturity-matched Treasury; and \(X_{i,t-1}\) is a vector of bond characteristics such as size and time since issuance. There are also time and cross-sectional fixed effects. The authors also look at the bond price, instead of the yield spread.

Benmelech & Bergman (2018a, table 3) find that there is a positive association between illiquidity and yield spread. The economic impact is sizable: A one-standard-deviation increase in the yield spread results in an increase between 57% and 79% of the unconditional mean of the illiquidity measure.

What about the nonlinearity due to the kink? Benmelech & Bergman (2018a) form 10 deciles of bond price to nonparametrically look for the kink. They estimate that

\[
\text{Illiquidity}_{i,t} = \beta_0 + \sum_{k=1}^{10} \beta_k \times \text{PriceDecile}_{i,t-1}^k + b_i \gamma + c_i \delta + \epsilon_{i,t},
\]

where Illiquidity is one of the three liquidity measures and PriceDecile is the set of 10 indicator variables based on the within-year deciles of bond price. There are also bond fixed effects and a vector of either year or year-end-by-month fixed effects. As before, they find a negative relation between price and illiquidity using all three measures of bond liquidity. They also find evidence of the predicted nonlinearity (Benmelech & Bergman 2018a, figure 2): “The predicted nonlinear, hockey-stick relation between illiquidity and price is readily observable” (p. 14).12 They conclude that “bond liquidity is determined by the informational-sensitivity structure of debt contracts” (p. 21).

Benmelech & Bergman (2018a) also look at maturity. Longer-maturity (privately produced) bonds should be less liquid, because there is greater uncertainty about the final payoff. The authors examine this hypothesis by defining five equal-sized quintiles of bond maturity and then examining the following regression specification:

\[
\text{Illiquidity}_{i,t} = \beta_0 + \sum_{k=1}^{10} \beta_k \times \text{MaturityQuintile}_{i,t-1}^k + b_i \gamma + c_i \delta + \epsilon_{i,t}.
\]

The results indicate that longer-maturity bonds are more illiquid. Although corporate bonds have varying degrees of information sensitivity, as shown by Kwan’s (1996) results, Benmelech & Bergman (2018a) show that, whatever their information sensitivity, such investment-grade bonds become more illiquid when their price goes down.

Benmelech & Bergman’s (2018a) study and other studies of corporate bond markets use price data from the Trade Reporting and Compliance Engine (TRACE) system. TRACE was introduced on July 1, 2002, by the National Association of Securities Dealers (NASD). The system was designed to increase posttrade transparency for corporate bonds because, for the first time, all NASD members were required to report prices, quantities, and other information for all secondary market transactions in corporate bonds.

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11The three standard, widely used measures are gamma (Roll 1984; Bao, Pan & Wang 2011), the Amihud illiquidity measure (Amihud 2002), and the implied round-trip cost (Bao et al. 2015).
12To address the causality issue, Benmelech & Bergman (2018a) also use instrumental variables, and confirm the findings.
What happened when TRACE was introduced? With respect to information sensitivity, the short answer appears to be: not much. TRACE started with BBB-rated bonds. Goldstein, Hotchkiss & Sirri (2007) studied the effects on BBB-rated bonds because these are the most information sensitive. They report that “both regulators and market participants believed the market for the highest rated and very large issues, which are less information sensitive and also have more close substitutes, would not behave in the same manner as lower rated or smaller issues” (pp. 238–39). Consistent with findings by Kwan (1996), as shown in Table 2, BBB-rated bonds are the most information sensitive of the investment-grade bonds (junk bonds are information sensitive). Looking at the BBB-rated bonds, Goldstein, Hotchkiss & Sirri (2007, p. 237) found that “depending on trade size, increased transparency has either a neutral or a positive effect on market liquidity, as measured by trading volume or estimated bid-ask spreads. Measures of trading activity, such as daily trading volume and number of transactions per day, show no relative increase, indicating that increased transparency does not lead to greater trading interest in our sample period.”

4.3. The Information Sensitivity of Bonds When the Information Environment Changes

The introduction of the new derivative instrument CDSs into the bond market changed the information environment of bonds. As explained by Gorton (2010), CDSs allow traders to take very large positions long or short on the credit risk of specific firms, much larger than the par value of a firm’s outstanding bonds. For example, a firm may have a bond with a par value of $100 outstanding, but a single trader can trade CDSs with a notional amount of $1,000 or more. This can make it much more profitable to produce private information because, for a fixed cost of producing information, a larger position can be taken. A small benefit to producing information can become profitable if a large amount can be traded. It is also empirically consistent with the finding of Blanco, Brennan & Marsh (2005) that CDS prices lead bond credit spreads. Price discovery occurs in the much more liquid CDS market.

CDSs were introduced on some companies, larger ones, and not all at the same time. When CDSs are introduced on a firm, then that firm’s bonds should become less liquid. This hypothesis was essentially tested by Das, Kalimipalli & Nayak (2014, p. 495), who found that “[u]sing an extensive sample of CDS and bond trades over the period 2002–2008, . . . the advent of CDS was largely detrimental. Bond markets became less efficient, evidenced no reduction in pricing errors, and experienced no improvement in liquidity.”

4.4. Municipal Bonds

Hammerling (2019) studies the US market for municipal debt when the monoline insurers, the companies that insured many of the bonds in this market, were downgraded or went bankrupt. She adapts the Benmelech & Bergman (2018a) approach to analyze the effects on municipal debt. She provides a variety of evidence showing that, following the events with the monolines, municipal debt switched from information insensitive to information sensitive. Unlike Benmelech & Bergman (2018a), however, Hammerling can use a differences-in-differences approach to show that the switch occurred in early 2012. She finds that not only previously insured bonds but also previously uninsured bonds become information sensitive.

Hammerling (2019) further shows that, once the municipal bonds become information sensitive, their prices become sensitive to information about municipalities’ debt service payments to tax revenue ratios, as well as pension commitments. Investors appear to use this information in
pricing the bonds. And municipalities show an increased use of their financial disclosures by, for example, changing the actuarial methods for valuing pension liabilities.

5. CONCLUSION

Money markets are not stock markets for a reason. The efficacy of money requires that its price not change, as it did during the US Free Banking Era. By design, the price system does not and should not work for money market instruments. Information insensitivity is created by debt-on-debt. Money markets are primary markets. Equity trades in secondary markets. Table 1 summarizes the characteristics of money markets versus those of stock markets. The differences are fundamental.

That the differences are fundamental has many implications. Since the money market price system is fixed at one to one with cash, other margins may need to adjust when there is bad news. Haircuts can rise, maturity can shorten, and collateral may improve, but quantities go to zero, a crisis. Furthermore, when short-term debt becomes information sensitive, few, if any, know what the price of the underlying collateral should be. Few are prepared to produce information about the collateral. There cannot be price discovery. As a result, in a crisis there are no markets for the collateral. Only the central bank or private bank clearinghouse can make a market for the collateral, via their discount windows. This is the risk with information-insensitive debt.

The central bank’s response to a crisis is also instructive. Rather than implement transparency, central banks do the opposite. Emergency lending programs are put into place, and these programs are designed to make loans in secret, protecting the anonymity of borrowers in order to avoid identifying weak banks, which might then face runs. Borrowers become stigmatized if their names are revealed. Also, as mentioned above, in an attempt to prevent revelation of weak financial institutions, the SEC instituted short-sale bans on the stock of 797 financial firms starting on September 18, 2008.

Regulatory responses to financial crises often seem to try to impose stock market–like policies on money markets. Above we have presented two examples of the policy responses that implemented more “transparency.” We saw such policies implemented with regard to securitization in Europe and MMFs in the USA. These policies backfired. Such policies destroy liquidity and moneyness. It follows from the informational view articulated here that intuitions and results from stock markets are not correct for money markets. The information characteristics that define these two markets are opposed. Thus, the notion of market discipline, for example, is not necessarily a good idea with regard to the private production of short-term debt. Mandating that banks issue contingent convertible debt just makes banks more likely to become information sensitive. And so on. Regarding Table 1, the goal cannot be for the money market column to look like the stock market column.

Short-term debt is an inherent feature of market economies. For the problems of transacting and storing value over short periods of time, short-term debt is the solution, but it is also the problem.

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