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The Spillover Effects of Hurricane Katrina on Corporate Bonds and the Choice Between Bank and Bond Financing*

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Abstract

We use an exogenous event, namely, the spillover effects of Hurricane Katrina on corporate bonds through the liquidation of bond holdings by insurance companies, to study how companies react to temporary changes in the relative availability of bond and bank financing. We find that the negative shock on bonds induces firms to shift from bond financing to bank-based borrowing and to shorten the debt maturity. This shift in debt policy does not revert in the long term. There is no significant change in capital structure, suggesting that the substitution from bonds to bank loans is sufficient for the amount of borrowing.

I. Introduction

A key question in finance is how a firm determines its debt policy. This determination involves choosing both the optimal mix between bond and bank-debt financing and the maturity of debt. The standard finance literature has primarily addressed this question in terms of an optimal arrangement to alleviate underlying information frictions (Diamond (1984)), and the debt choice has been described in terms of its "demand" side (i.e., the demand of debt is driven by the borrowers' characteristics) (Diamond (1991), Rajan (1992)).

However, the borrower's choice may also be affected by "supply" factors (i.e., the demand for funds by borrowers is conditioned by the characteristics of lenders). For example, the 2008–2009 global financial crisis has brought attention to the transmission mechanism related to the need for financial intermediaries, such as mutual funds, hedge funds, or insurance companies, to meet the withdrawals of money by their investors (Bernardo and Welch (2004), Coval and Stafford (2007), and Shleifer and Vishny (2011)).

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If a shock induces financial intermediaries to sell a class of assets (e.g., corporate bonds), the ensuing drop in bond prices may affect the choice of the firm to choose different forms of debt financing. In particular, the negative shock affecting the demand for bonds will require firms to choose whether to redirect their financing toward bank loans or to move from long-term bond financing to short-term financing. In other words, supply shocks in the bond market may directly impact how the firm determines its debt policy when choosing between bank and bond financing and determining the maturity of debt.

Moreover, even if such market-driven shocks (unlike firm-specific characteristics) are by nature temporary, they may increase the perceived credit supply uncertainty in the financing conditions of the affected firms and raise their risk attitude vis-à-vis bond financing. Therefore, debt policy adjustments may generate long-term changes in the debt choice of the affected firms, thereby inducing a long-term shift in the debt structure.

To study these questions, we identify exogenous variations in the firm's specific capital habitat independent of the firm's characteristics that *differentially* affect the ability of the firms to borrow vis-à-vis the different classes of lenders. We focus on Hurricane Katrina, a natural disaster occurring in 2005 with the largest insured losses in U.S. history, which significantly affects major bondholders such as property & casualty and reinsurance companies. We examine how it affects bond issuers by changing their borrowing policy in terms of the types of lenders they resort to. We explore how a shift in the demand for bonds from a set of specific firms (i.e., those firms financed by insurance companies exposed to the Katrina shock) affects the choice of debt financing.

This setup provides an ideal testing ground for two reasons. First, insurance companies are the largest corporate bondholders. At the end of the second quarter of 2005, insurance companies held $574 billion of publicly issued corporate bonds. Second, corporate bonds are infrequently traded and are dominated by institutional investors who are, presumably, better informed. The price impact, if there is any, caused by shocks to property insurance and reinsurance companies that need to liquidate asset holdings after Hurricane Katrina is likely to be stronger.

We expect that the large insured loss of Hurricane Katrina induces property and reinsurance companies to liquidate their bond stakes, which negatively affects the bond prices. The ensuing shock may increase the financing uncertainty of the affected firms and raise their risk attitude against bond financing. Therefore, we expect that firms react by redirecting their debt financing toward bank loans. Using a novel data set on quarterly institutional bond holdings around the Hurricane Katrina period, we exploit the cross-sectional variations in the fraction of institutional bond ownership by property and reinsurance companies before Katrina and examine how these cross-sectional variations are related to bond performance and debt financing after Katrina.

First, we investigate whether the insurance companies affected by Katrina begin to liquidate their bond holdings after Katrina. We identify the property insurance and reinsurance companies that experience the largest exposure to Hurricane Katrina ("exposed property insurance and reinsurance companies"). These companies reduce their bond holdings by 6.5 billion from the second quarter of 2005 to the third quarter of 2005, a 14% decrease from the second quarter of

2005. For the same pool of bonds, property (re) insurance companies with low exposure to Katrina reduce their bond holdings by 0.9 billion, representing a 1% decrease from the second quarter of 2005. In contrast, in the same period, life insurance firms slightly increase their holdings of the same bonds.

Next, we test the effects on bond prices and therefore indirectly on the cost of borrowing for the firm. We find that pre-Katrina exposed property and reinsurance ownership is not significantly related to bond performance during the 2 weeks before the formation of Katrina. In contrast, we document a strongly negative relationship between Katrina-period abnormal bond returns around the 2 weeks during which Katrina is formed and dissipated and pre-Katrina bond ownership by exposed property and reinsurance companies. A 5% increase in pre-Katrina ownership by exposed property insurance and reinsurance companies is associated with a 53-basis-point decrease in risk-adjusted bond returns, suggesting that the (short term) excess demand curve for bonds is not perfectly elastic (Shleifer (1986), Wurgler and Zhuravskaya (2002), Coval and Stafford (2007)). We find that price reversal appears 6 months after Hurricane Katrina struck.

Next, we test the corporate response to such a shock. We find a significantly negative relationship between the pre-Katrina exposed property and reinsurance ownership and both the fraction of bond financing and the maturity of debt financing. Firms react to the shock in the bond market by both resorting more to bank-based financing and, as a result, shortening the overall maturity of debt financing. A 5% higher pre-Katrina exposed property and reinsurance ownership is related to an 11% lower fraction of bond financing (a 27% decrease from the unconditional mean), a 19% lower debt maturity when compared to the unconditional mean.

The substitution from bonds to bank financing is weaker if the forced sold bonds are picked up by more stable bondholders such as life insurance companies. In contrast, the substitution effect is stronger for firms located in areas with higher availability of local bank supply, which suggests that the credit supply condition is an important consideration for firms to determine their debt policy, consistent with the recent findings on debt structure and bank/bond substitutions (Colla, Ippolito, and Li (2013), Massa, Yasuda, and Zhang (2013), and Becker and Ivashina (2014)).

Does this debt recomposition revert in the long term? Even if the impact on prices seems to revert after 6 months, we find that the impact on the substitution between bank and bond financing and the impact on the maturity of debt financing is persistent. This finding suggests that even if the firm can potentially revert to the old debt-financing structure, the shock and following uncertainty reduces its willingness to do so; thus, the substitution to bank debt tends to be persistent in the long term.

In addition, we find that the internal change in the composition between bank and bond debt does not translate to a change in the capital structure. This evidence suggests that the shock to the bond market is absorbed by the bank market and by a reduction in the maturity of debt.

Our results contribute to different stands of literature. First, we contribute to the "supply-side" view of corporate financial policies. Previous research documents that firms tend to switch from bank loans to commercial paper or corporate bonds when monetary policy is tight (Kashyap, Stein, and Wilcox (1993), Becker and

Ivashina (2014)). We provide evidence in the other direction, that is, exogenous liquidity shocks to the bond investor base cause bond issuers to switch from corporate bonds to bank debt.[1]

Even though a shift to a substitute in the presence of changes in relative prices is one of the basic ideas in microeconomics, in our context, the specific alternative form of debt financing the affected firms will switch to is not obvious. Indeed, the firms may simply resort to short-term bonds such as commercial paper for a cheaper source of financing without seeking bank loans. However, replacing with short-term public debt will exacerbate the refinancing/rollover risk of the issuing firm (He and Xiong (2012)). Our results help to shed light on this issue by documenting that firms do indeed shift from bonds to bank-based financing in the face of supply shocks to the bond investor base. Moreover, we document that credit supply conditions are important considerations to determine such a shift. For example, when the liquidated bonds are absorbed by a more stable bondholder base (i.e., life insurance companies), such substitution effects are attenuated.

Second, our results contribute to the literature that studies the liquidity shocks in the corporate bond market. Ellul, Jotikasthira and Lundblad (2011) and Da and Gao (2009) examine price pressure caused by insurance sales if the bond is downgraded from investment grade to below investment grade. Instead of looking at firm-specific events, we focus on a purely exogenous shocks to major bond investors and explore their effects on corporate debt policies. The exogeneity of the shocks to the bondholders is crucial, as a shock to firm-specific characteristics will affect the ability of the firm to borrow vis-à-vis all the different types of lenders. In contrast, a shock that only affects one set of lenders (the institutional investors holding the bonds) will affect just the availability to borrow from that class of lender and therefore allows us to study the debt policy of the affected firms vis-à-vis other firms. We contribute by showing that, even though the negative price impact due to the liquidity shock to Katrina-exposed insurance companies tends to be short term, the subsequent change in the firm's debt policy is persistent and does not revert in the long term. This evidence suggests that even short-term market-driven shocks can have a long-term impact on a firm's financial habitat.

II. Data and Variables

A. Hurricane Katrina

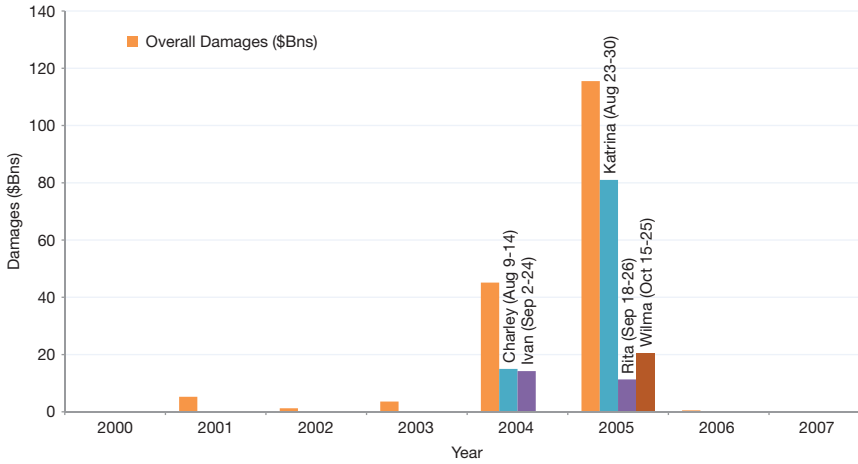
Hurricane Katrina (Aug. 23–30, 2005) is the costliest natural disaster in the history of the United States. While hurricanes are predictable, the amount of damage is not. In the case of Hurricane Katrina, the total property damage was more than $81 billion (2005 USD). The American Insurance Services Group estimates that Katrina is responsible for $40.6 billion of insured losses (Knabb,

[1]The paper that is close to ours is Lemmon and Roberts (2010); they use the collapse of Drexel Burnham Lambert in 1989 to examine the substitution from junk bonds to bank debt for below-investment grade firms.

FIGURE 1

Yearly Atlantic Hurricane Damages (2000—2007)

Figure 1 shows plots of the amount of property damages from Atlantic hurricanes for the period 2000–2007. We include the yearly aggregate damages (blue bars) and damages from specific hurricanes of each year with the amount of damages higher than $10 bns. For those hurricanes, we report the hurricane name and the period during which the hurricane is formed and dissipated. Data on the damages are obtained from the Annual Summaries of North American Storms (1872–2008) by the Monthly Weather Review of the National Hurricane Center, available at http://www.aoml.noaa.gov/general/lib/lib1/-nhclib/mwreviews/mwreviews.html.



Rhome, and Brown (2005)). A special report by Towers Perrin Co. (2005) studying the impact of Hurricane Katrina on the insurance industry estimates the range of privately insured loss to be between $40 and $55 billion. This amount represents a large exogenous shock to the property insurance and reinsurance industry, especially for insurance companies with large business exposure to Katrina.

This fact is evident from Figure 1, which plots the amount of property damages caused by Atlantic hurricanes for the period 2000–2007, based on the data from the Annual Summaries of North American Storms (1892–2008) by the Monthly Weather Review of the National Hurricane Center. The estimated damages of Hurricane Katrina are more than 4 times larger than the damages of the previous costliest hurricane (Hurricane Charley, Aug. 2004) and exceed the overall damages of all other major hurricanes pooled together.

The impact of Hurricane Katrina on insurance companies can be seen from Figure 2, where we plot the percentage change in bond yield spreads of insurance companies around the period of Hurricane Katrina (Aug. 1, 2005–Oct. 3, 2005). We observe that before Katrina, there was no significant change in the credit spreads of insurance companies, while immediately after Katrina, in a month's time, the credit spreads of property insurers with high exposure to Katrina increased by almost 20%, while the credit spreads of life insurers and property insurers with low exposure to Katrina increased by a much smaller amount (less than 5%).

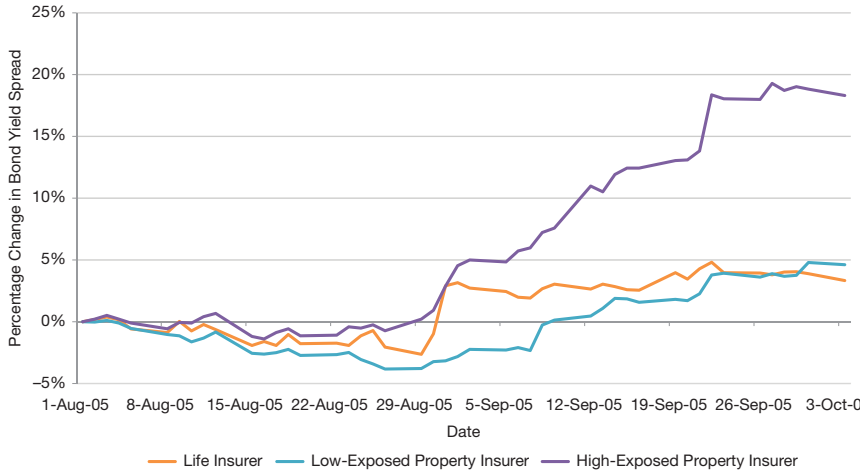
B. Identification of Katrina-Exposed Insurance Companies

We identify the property insurance and reinsurance companies with high exposure to Katrina on the basis of the 2005 special report on Hurricane Katrina

FIGURE 2

Percentage Change in Credit Spreads of Insurance Companies Around Hurricane Katrina

Figure 2 shows plots of the percentage change in bond yield spreads of insurance companies around the period of Hurricane Katrina (Aug. 1–Oct. 3, 2005). We include all the bonds issued by insurance companies and obtain their daily (option-adjusted) yield spreads as reported in the Bank of America Merrill Lynch U.S. Corporate and High Yield Master index database. The option-adjusted yield spread measures the amount by which a risk-free spot curve must be raised or lowered so that the resulting discounted cash flows equal the market price of the bond. We classify insurance companies into life insurers, property insurers with high exposure to Katrina, and property insurers with low exposure to Katrina. We calculate the average daily yield spread for each type of insurers. Next on each day forward, we calculate the percentage change with respect to the level of yield spread on Aug. 1, 2005.



provided by the Holborn Corporation. This independent reinsurance brokerage firm lists the names of property insurance companies and their 2004 market shares in Louisiana, Mississippi, and Alabama and the names of property insurance and reinsurance companies that have credit rating changes immediately after Katrina. For the reinsurance companies, our identification strategy is based on examining the companies experiencing negative credit rating changes (negative watch or downgraded) immediately after Katrina. Among all the property insurance companies and the reinsurance companies, we select the top 10 property insurance companies (by their market shares in the Gulf states)[2] and 8 reinsurance companies (by their credit rating changes) that can be identified as managing firms in the Lipper eMAXX database (manually matched by the name of the managing firm). We list the names of these companies in Table 1.

Even though we only identify 18 property & casualty insurance and reinsurance companies with high exposure to Hurricane Katrina, these insurance companies are among the largest in the bond market and have huge amounts of corporate bond holdings. In total, these insurance-owned asset management companies hold 48.98 billion dollars of corporate bonds at the end of the second quarter of 2005 and 40.47 billion dollars of the bonds at the end of the third quarter of 2005. These amounts suggest that these insurance companies sold 8.51 billion dollars of corporate bonds from the second quarter of 2005 to the third quarter of 2005. The

[2]We rely on their 2004 market shares including both personal and commercial lines.

TABLE 1

Identification of Insurance Companies with High Exposure to Hurricane Katrina

Table 1 reports property & casualty and reinsurance companies that have high business exposure to Hurricane Katrina. We use data from the Holborn Corporation's (2005) Hurricane Katrina report (http://www.holborn.com/holborn/-reportsKatrina.html) to identify these insurance companies. The Holborn Report provides the names of insurance companies with their 2004 market shares in the U.S. Gulf region, and the information on whether they had rating or rating outlook changes immediately after the hurricane. For property & casualty insurance companies, we consider the top 10 property insurance companies that can be identified as managing firms in the Lipper/eMAXX database by their 2004 market shares (including both personal and commercial lines) in the states of Louisiana, Mississippi, and Alabama. We report the identities of these insurance companies in Panel A. For reinsurance companies, because the concept of market shares in a geographical region does not apply, so we identify reinsurance companies by whether they experienced adverse rating downgrades immediately after Hurricane Katrina. Panel B reports a list of 8 reinsurance companies with negative rating (outlook) changes that can be matched in the Lipper/eMAXX database as managing firms.

Panel A. Identification of Property & Casualty Insurance Companies

Insurer Name	Insurer Type	Market Share in Louisiana, Mississippi, and Alabama: Year 2004
State Farm Insurance Company	Property & Casualty Insurer	26.62%
Allstate Insurance Co. Group	Property & Casualty Insurer	10.03%
Progressive Casualty Group	Property & Casualty Insurer	9.39%
Alfa Insurance	Property & Casualty Insurer	6.83%
Mississippi Farm Bureau Casualty Insurance	Property & Casualty Insurer	5.15%
United Services Automobile Association	Property & Casualty Insurer	3.09%
Nationwide Assurance	Property & Casualty Insurer	2.72%
American Modern Home Insurance	Property & Casualty Insurer	1.91%
American International Insurance	Property & Casualty Insurer	1.66%
St. Paul Travelers Companies	Property & Casualty Insurer	1.60%

Panel B. Identification of Reinsurance Companies

Insurer Name	Insurer Type	Changes in Credit Rating After Hurricane Katrina
Ace American Reinsurance	Reinsurer	S&P Action: negative watch
Alea North America Insurance	Reinsurer	AM Best Action: negative watch
Endurance Reinsurance Corp. of America	Reinsurer	AM Best Action: negative watch
Odyssey America Reinsurance	Reinsurer	AM Best Action: negative watch
Olympus Insurance	Reinsurer	AM Best Action: downgrade
Partner Reinsurance United States	Reinsurer	AM Best Action: negative watch
Transatlantic Reinsurance United States	Reinsurer	AM Best Action: negative watch

largest reduction of corporate bond holdings came from the State Farm Insurance Company (i.e., the one with the largest market share in the Gulf region), reducing its holdings from 10.75 billion dollars to 5.32 billion dollars.

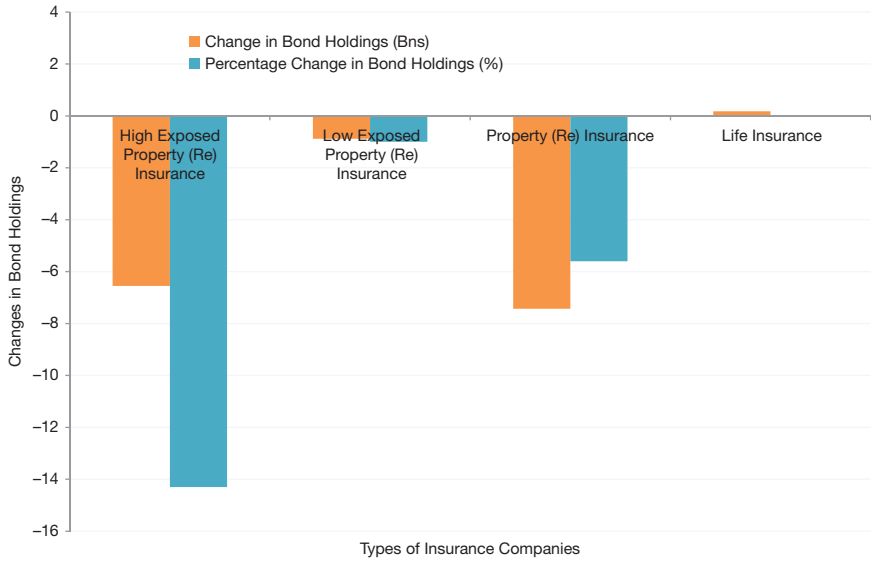
In Figure 3, we plot the change in bond holdings of property (re) insurance and life insurance companies from the second quarter of 2005 to the third quarter of 2005. Overall, the highly exposed property (re) insurance companies reduced their bond holdings by 14.2% from the second quarter of 2005. For the same pool of bonds, property (re) insurance companies with low exposure to Katrina reduced their bond holdings by 0.9 billion, representing a 1% decrease from the second quarter of 2005. In contrast, in the same period, life insurance companies slightly increased their holdings of the very same bonds.

The proceeds from selling the bonds may be directly used to cover claimed losses or go to cash or cash equivalent for future redemptions. To address this issue, we look at the pattern of paid losses and cash holdings of these impacted insurance companies in 2005. If we focus on paid losses, we find that there is little change in paid losses from 2005:Q1 to 2005:Q2. However, there is a dramatic 9.3 billion increase in paid losses from 2005:Q2 to 2005:Q3. From Q3 to Q4, there is a reduction of 4.1 billion in paid losses by these insurance companies.

FIGURE 3

Change in High Exposed Property (Re) Insurance Bond Holdings (2005:Q2–2005:Q3)

Figure 3 shows plots of the change in bond holdings of (high exposed) insurance companies from 2005:Q2 to 2005:Q3. The data on quarterly institutional bond holdings are from Lipper/Emaxx fixed-income database. The property (re) insurance companies with high exposure to Hurricane Katrina are identified in Table 1. To avoid the issue that bond holdings can change simply because some bonds are matured during this period, we concentrate on the bonds that are held by those insurance companies and with time to maturity being more than 1 year at the end of 2005:Q2. The blue bar represents the change in bond holdings in dollar amounts (bns). The red bar represents the percentage change compared to the level of aggregate bond holdings at 2005:Q2. We also plot the (percentage) change in holdings based on the same pool of bonds for property (re) insurance companies with low exposure to Katrina, property (re) insurance companies in general and life insurance companies.



These results suggest that the highest amount of Katrina-related redemption claims occurred soon after Katrina, and the insurance companies have responded to the urgency by quickly redeeming these claims. In contrast, the results show that there is little change in cash holdings. There is scant evidence of large cash holdings present in the balance sheets of these insurance companies to meet the surge of insured damages from Hurricane Katrina, suggesting that insurance companies rely on investment assets (mostly in bonds) and policy premiums to meet large, unexpected redemption claims.

C. Data and Variable Definitions

We compile our data from several sources. Institutional bond holdings are from Lipper's eMAXX fixed-income database. The database provides information on quarterly ownership of more than 40,000 fixed-income issuers with $5.4 trillion in total fixed-income par amount, both public issues and private placements. We focus on the bond ownership by property insurance and reinsurance companies at the end of the second quarter of 2005.

Monthly bond returns and detailed credit ratings at the level of bond issues are drawn from the Bank of America Merrill Lynch U.S. Corporate and High Yield

Master bond index database. This database is a combination of the Merrill Lynch Corporate Master Index and the Merrill Lynch Corporate High Yield Index previously used by Schaefer and Strebulaev (2008). The database covers most rated U.S. publicly issued corporate bonds (Acharya, Amihud, and Bharath (2013)). The data on bond characteristics such as bond maturity, amount outstanding, callability, coupon rates, and coupon frequency are from the Mergent's Fixed Income Security Database (FISD). Firm-level accounting information is from the CRSP/Compustat Merged database.

We merge Lipper's data with FISD and Merrill Lynch index using the 8-digit bond issue CUSIP and merge with CRSP/Compustat using the 6-digit CUSIP of the issuer. We drop bonds with rare special features such as putable bonds, convertible bonds, and bonds denominated in foreign currencies. In Aug. 2005, our sample includes 1,583 publicly traded corporate bonds issued by 564 public firms, among which 1,064 bonds are investment grade and 519 bonds are below investment grade.

We rely on the tick-by-tick bond transaction data from Trade Reporting and Compliance Engine (TRACE) to calculate daily bond returns. TRACE is the Financial Industry Regulatory Authority (FIRA) over-the-counter (OTC) corporate bond market real-time price dissemination service. Following Bessembinder, Kahle, Maxwell, and Xu (2008), we eliminate trades with extreme absolute bond returns of more than 0.2. The price reported by TRACE reflects the "clean" price, which does not include accrued interest. We supplement the TRACE data with coupon rates and coupon frequency from Mergent's FISD to calculate the accrued interest. Then, we merge the daily bond returns from TRACE into our original sample.

We now describe the construction of the main variables. Our focus variable is property insurance (and reinsurance) ownership, which is defined at the bond level as the par amount held by property insurance companies at the end of the quarter divided by the amount of bonds outstanding. We distinguish the ownership of property insurance companies by their exposure to Hurricane Katrina. *Property insurance ownership (high exposure)* is defined as the par amount held by property companies with high exposure to Katrina at the end of the quarter divided by the amount of bonds outstanding. *Property insurance ownership (low exposure)* is defined as par amount held by other property insurance companies at the end of the quarter divided by the amount of bonds outstanding. In particular, we focus on the pre-Katrina ownership at the end of the second quarter of 2005.

Next, we define bond-level control variables. *Other institutional bond ownership* is the par amounts held by other institutions except property insurance companies in the Lipper database at the end of the quarter divided by the amount of bonds outstanding. *Amount outstanding* is the par value of the offering amount in millions of dollars. *Coupon rate* is the current applicable annual interest that the bond's issuer is obligated to pay to the bondholders. *Time-to-maturity* is defined as (maturity date – current date)/360. *Callability* is a dummy variable equal to 1 if the bond is callable and 0 otherwise. *Rating fixed effects* are 20 indicator variables, each corresponding to the Moody's credit rating category from AAA to CCC.

We also have firm-level controls. *Market value of assets* is defined as stock price × shares outstanding + short-term debt + long-term debt + preferred stock liquidation value – deferred taxes and investment tax credits. *Market-to-book* is the market value of assets/book assets. *Total debt* is long-term debt + short-term debt. *Book leverage* is total debt/book assets. *Firm size* is the log value of book assets. *Cash holding* is cash and cash equivalents/book assets. *Profitability* is the income before extraordinary items/book assets. *Institutional bond turnover* is the issue amount weighted-average turnover by bond institutional investors.

D. Summary Statistics

We present summary statistics of the variables in Table 2. In Panel A, we report the number of observations, the mean, the 1-percentile, the 99-percentile and the standard deviation. At the end of the second quarter in 2005, there are 322 property insurance companies identified as managing firms in the Lipper eMAXX database, with $90 billion public bond holdings. On average, they hold 5.4% of the total bonds outstanding (the average issue size is $487.7 million). There are large cross-sectional variations across different bonds. These variations range from 0% (1-percentile) to 25.2% (99-percentile), with a standard deviation of 5.6%. The level of property ownership is higher for investment grade bonds (6.9%) than for below investment grade bonds (2.3%), consistent with insurance companies being restricted from holding below investment grade bonds.

If we break down the bond ownership of property insurance companies by exposure to Hurricane Katrina, we find that, on average, the 18 highly exposed property insurance companies hold 1.3% of the bonds outstanding. Such ownership ranges from 0% (1-percentile) to 12% (99-percentile), with a standard deviation of 2.4%. For non-highly affected property insurance companies, we find that, on average, they hold 4.1% of bonds outstanding, ranging from 0% (1-percentile) to 20% (99-percentile) with a standard deviation of 4.4%. Even though the average level of exposed property insurance ownership seems small, it is actually quite significant when compared to the overall trading volume of affected bonds in the 4 weeks around the Katrina month (Aug. 22, 2005, to Sept. 18, 2005).

The total trading volume of corporate bonds held by these exposed insurance companies in the month after Katrina is 42.93 billion.[3] This number suggests that the 8.51 billion dollar reduction in corporate bond holdings by the exposed insurance companies represents 20% of the total trading volume of these bonds in the Katrina month. The reduction is especially significant for bonds with more than 1% of exposed property ownership. For these bonds, changes in these holdings from 2005:Q2 to 2005:Q3 for high-exposure property insurance companies represent 40% of the trading volume in this period. More importantly, the existence of a relevant cross-sectional variation in the pre-Katrina exposed property insurance ownership allows us to trace the impact of Hurricane Katrina on corporate bonds through the channel of property insurance companies' sales.

[3]Given that it is not possible to calculate an exact amount of trading volume from the TRACE data, we assume the trade is 3 million if the trade size is "more than 1 million," and assume 10 million if the trade size is "more than 5 million"; then, we calculate the total trading quantities in the Katrina month and divide the result by 2 (accounting for the trade direction) for each bond.

TABLE 2

Summary Statistics

Table 2 reports summary statistics of the main variables used in the subsequent analysis. Our data come from multiple sources. The data on institutional holdings of corporate bonds are from Lipper's eMAXX fixed income database. The data on monthly bond characteristics in the secondary market are from the Bank of America Merrill Lynch U.S. Corporate and High Yield Master bond index database. The data on characteristics of new bond issuances are from Mergent FISD. We obtain the tick-by-tick bond transaction data from TRACE and individual loan-transaction data from LPC's Dealscan. The list of property (re) insurance companies with high exposure to Katrina is reported in Table 1. The rest of the property (re) insurance companies are considered to have low exposure to Katrina. Panel A reports the number of observations, the mean, the 1-percentile, the 99-percentile and the standard deviation. We restrict the sample of bonds to have non-zero property (re) insurance ownership. For bond ownership variables, we report the pre-Katrina summary statistics as of the end of 2005:Q2. For firm accounting variables, we report the pre-Katrina summary statistics as of the end of 2004. Panel B reports bond/firm characteristics separately by bonds with high life insurance ownership (life insurance ownership above the sample median), bonds with high property insurance ownership (property insurance ownership above the sample median) and bonds with high mutual fund ownership (mutual fund ownership above the sample median).

Panel A. Summary Statistics of Main Variables

Variables	Level	*N*	Mean	1%	99%	Std. Dev.
TOTAL_INSTITUTIONAL_OWNERSHIP	Bond	1583	48.6%	8.1%	99.8%	19.3%
LIFE_INSURANCE_OWNERSHIP	Bond	1583	29.3%	0.0%	80.7%	20.6%
PROPERTY_INSURANCE_OWNERSHIP	Bond	1583	5.4%	0.0%	25.2%	5.6%
PROPERTY_INSURANCE_OWNERSHIP (HIGH KATRINA EXPOSURE)	Bond	1583	1.3%	0.0%	12.0%	2.4%
PROPERTY_INSURANCE_OWNERSHIP (LOW KATRINA EXPOSURE)	Bond	1583	4.1%	0.0%	20.0%	4.4%
AMOUNT_OUTSTANDING (MILLIONS $)	Bond	1583	487.68	100	2500	416.97
COUPON_RATE	Bond	1583	6.6%	2.9%	10.6%	1.7%
TIME_TO_MATURITY (YEARS)	Bond	1583	8.80	1.04	30.16	7.30
CALLABILITY	Bond	1583	0.79	0.00	1.00	0.41
BOND_TURNOVER	Bond	1583	0.19	0.08	0.58	0.10
MARKET_TO_BOOK	Firm	564	1.18	0.13	3.58	0.63
BOOK_LEVERAGE	Firm	564	0.34	0.02	0.92	0.18
FIRM_SIZE	Firm	564	8.26	5.04	11.59	1.46
CASH_HOLDING	Firm	564	0.07	0.00	0.40	0.08
PROFITABILITY	Firm	564	0.04	−0.19	0.18	0.06

Panel B. Summary Statistics by Institutional Types

Bond/Firm Characteristics	Bonds with High Life Insurance Ownership	Bonds with High Property Insurance Ownership	Bonds with High Mutual Fund Ownership
AMOUNT_OUTSTANDING	461.02	533.81	439.24
TIME_TO_MATURITY	10.88	7.52	7.99
COUPON RATE	6.27%	5.92%	7.01%
CALLABILITY	0.81	0.76	0.83
BOND_TURNOVER	0.15	0.16	0.23
MARKET_TO_BOOK	1.17	1.22	1.09
BOOK_LEVERAGE	0.31	0.33	0.38
FIRM_SIZE	9.20	9.34	8.55
CASH_HOLDING	0.06	0.07	0.07
PROFITABILITY	0.05	0.05	0.03

In Panel B of Table 2, we separately report bond and firm characteristics by bonds with high life insurance ownership (life insurance ownership above sample median), bonds with high property insurance ownership (property insurance ownership above sample median), and bonds with high mutual fund ownership (mutual fund ownership above sample median). Not surprisingly, bonds held by life insurance companies tend to have longer time-to-maturity and lower turnover than do bonds held by property insurance companies and mutual funds.

III. Changes in Insurance Ownership Around Hurricane Katrina

We start by focusing on the changes in insurance bond ownership around Hurricane Katrina and asking whether property insurance companies, especially

TABLE 3

Changes in Bond Ownership by Insurance Companies Around Hurricane Katrina

Table 3 reports the results on the changes of insurance bond ownership around Hurricane Katrina. The analysis is at the bond level. The dependent variable in columns 1 and 2 is the change of insurance ownership from 2005:Q1 to 2005:Q2 (pre-Katrina period). The dependent variable in columns 3 and 4 is the change of insurance ownership from 2005:Q2 to the 2005:Q3 (Katrina period). We regress it on the level of insurance ownership at the end of the previous quarter. Insurance ownership is defined as the holdings of insurance companies divided by the bond issue amount outstanding. In columns 2 and 4, we add 20 Moody's credit rating fixed effects from AAA to CCC. We perform a Chow test to evaluate the differences in coefficients between columns and report the chi-squared statistic. Panel A examines the change of ownership by life insurance companies. Panel B reports the results on the change of ownership by property (re) insurance companies. Panel C reports the results on the change of ownership by property (re) insurance companies with high exposure to Hurricane Katrina.

	Dependent Variable: CHANGE_IN_INSURANCE_OWNERSHIP			
	Change from 2005:Q1 to 2005:Q2		Change from 2005:Q2 to 2005:Q3	
	1	2	3	4
Panel A. Changes in Life Insurance Ownership				
LIFE_INSURANCE_OWNERSHIP (2005:Q1)	−0.020*** (−3.06)	−0.049*** (−4.15)		
LIFE_INSURANCE_OWNERSHIP (2005:Q2)			−0.022** (−2.05)	−0.044*** (−3.30)
Rating fixed effects	–	Yes	–	Yes
R^2	0.0119	0.0717	0.0066	0.0300
No. of obs.	1453	1453	1453	1453
X^2 statistic Test of diff. in coefficients			(3) vs.(1) 0.02	(4) vs.(2) 0.19
Panel B. Changes in Property (Re) Insurance Ownership				
PROPERTY_INSURANCE_OWNERSHIP (2005:Q1)	−0.023** (−2.30)	−0.039** (−2.47)		
PROPERTY_INSURANCE_OWNERSHIP (2005:Q2)			−0.188*** (−8.10)	−0.199*** (−7.84)
Same specification as in Panel A	Yes	Yes	Yes	Yes
R^2	0.0132	0.0373	0.2141	0.2458
X^2 statistic Test of diff. in coefficients			(3) vs.(1) 51.25***	(4) vs.(2) 32.53***
Panel C. Changes in Property (Re) Insurance Ownership (High Exposure to Katrina)				
PROPERTY_INSURANCE_OWNERSHIP AT 2005:Q1 (LOW EXPOSURE)	−0.025 (−1.25)	−0.028 (−1.24)		
PROPERTY_INSURANCE_OWNERSHIP AT 2005:Q2 (HIGH EXPOSURE)			−0.323*** (−10.75)	−0.319*** (−10.62)
Same specification as in Panel A	Yes	Yes	Yes	Yes
R^2	0.0217	0.0327	0.4559	0.4672
X^2 statistic Test of diff. in coefficients			(3) vs.(1) 85.13***	(4) vs.(2) 76.23***

those with high exposure to Katrina, liquidate a higher portion of their bond holdings. We then compare this behavior to that of life insurance companies, the ones not affected by Katrina. The analysis is at the bond level, and the focus is on the periods before and after Katrina. For both periods, we relate the change in bond ownership to the level at the beginning of the period. In the pre-Katrina period, we consider how the change in insurance ownership from 2005:Q1 to 2005:Q2 is related to the level of ownership at 2005:Q1. In the Katrina period, we examine how change in insurance ownership from 2005:Q2 to 2005:Q3 is related to the level of ownership at 2005:Q2.

We report the results in Table 3. Panel A reports the results on the change of ownership by life insurance companies. It shows a certain degree of mean reversion between quarters. That is, the change in life insurance ownership from 2005:Q1 to 2005:Q2 is negatively related to the level of ownership at 2005:Q1. We observe similar patterns from 2005:Q2 to 2005:Q3. Indeed, the X^2 statistic from the Chow

test is only 0.02, indicating that there is no difference in the explanatory power of last-quarter life insurance ownership between the pre-Katrina period and the Katrina period.

Panel B of Table 3 presents the results on the change of ownership by property insurance companies. The results are striking when compared to Panel A. In the pre-Katrina period, column 1 shows that the change in property insurance ownership from 2005:Q1 to 2005:Q2 is modestly negatively related to the level of property ownership at 2005:Q1, with a coefficient of −0.023 and a *t*-statistic of −2.30. The results are very different in the Katrina period. Column 4 indicates that the change in property insurance ownership from 2005:Q2 to 2005:Q3 is strongly negatively related to the level of property ownership at 2005:Q2, with a coefficient of −0.188 and a *t*-statistic of −8.10. The R^2 increases from a base 1% to 21%. The X^2 statistic from the Chow test is 51.25, suggesting a significant difference in the explanatory power of last-quarter property insurance ownership between the pre-Katrina period and the Katrina period. Therefore, on average, property insurance companies liquidate 20% of their bond holdings from the second quarter of 2005 to the third quarter of 2005. Even after controlling for credit rating fixed effects, the difference remains significantly strong.

The shock that drives the striking difference between Panel A and Panel B in Table 3 should not be something that influences the insurance industry as a whole; otherwise, life insurance companies and property insurance companies should react similarly. Rather, the shock must be something that affects just property insurance companies and occurs in the third quarter of 2005. Given that there are no major hurricanes in 2005 before Katrina and given the large insured losses caused by Katrina, we believe that this difference can only be traced to the needs of property insurance companies to liquidate their bond holdings to face the upcoming claims related to Hurricane Katrina.

If our identification is correct, we expect even stronger results for the bonds characterized by ownership by property insurance companies with high exposure to Katrina. Indeed, in Table 3 Panel C, we find that the change in holdings by highly exposed property insurance companies from 2005:Q2 to 2005:Q3 is strongly negatively related to their level of ownership at 2005:Q2, with a coefficient of −0.323 and a *t*-statistic of −10.75. The R^2 is now 45%. The X^2 statistic from the Chow test is 85.13, suggesting that on average, property insurance companies with high exposure to Katrina liquidate 32% of their holdings from 2005:Q2 to 2005:Q3.

Overall, this evidence shows that property insurance companies with high exposure to Katrina liquidate their bond holdings after the hurricane. We do not observe a similar behavior for life insurance companies. Given the selling behavior of the property insurance companies and the illiquid nature of the bond market, is there any price impact on bond performance around the Katrina period? This question is the topic of Section IV.

IV. Bond Performances Around Hurricane Katrina

In this section, we look at the link between risk-adjusted bond returns around the Katrina period and the property insurance companies' stakes in the bonds before the event. We follow the same methodology as Baker, Coval, and Stein (2007)

and Ellul, Jotikasthira, and Lundblad (2011) and use pre-event institutional bond ownership to predict postevent abnormal bond returns. The pre-Katrina property insurance ownership is exogenous with respect to the bond returns after Katrina, given the total unexpectedness of Katrina damages.

The economic rationale can be explained with a simple example. Suppose that Start Farm Insurance has 10 billion in bond holdings before Katrina, which are invested in 2 bonds, 8 billion in bond A and 2 billion in bond B. For each bond, the total amount outstanding is 100 billion. Therefore, before Katrina, State Farm ownership in bond A is 8%, and its ownership in bond B is 2%. After Katrina, State Farm needs to immediately liquidate 5 billion to deal with insurance claims. Ideally, Start Farm would want to liquidate its bonds in proportion to the amounts it owns and keep the portfolio balanced. It should sell 4 billion in bond A and 1 billion in bond B. As a result, State Farm's ownership in bond A would drop from 8% to 4%, and the ownership in bond B would drop from 2% to 1%. Therefore, the forced liquidation will have a larger impact on bond A than on bond B, given the higher pre-Katrina ownership.

We consider the bond returns around the Hurricane Katrina period. Specifically, for each bond in an event window within the 180 days around Hurricane Katrina, we calculate the rating-adjusted cumulative bond returns in excess of the average bond returns in the bond's rating category. We use 20 monthly credit rating categories from AAA to CCC from the Bank of America Merrill Lynch index database to estimate the risk-adjusted bond returns. We report the results in Table 4. In Panel A, we provide a matching sample analysis, in which we define "treated" bonds as those with pre-Katrina property insurance ownership (high exposure) above the top quintile. For each treated bond, we identify a "matched" low exposure bond with the closest propensity-matching scores based on major bond characteristics: issue amount outstanding, coupon rate, and time-to-maturity.

We report the cumulative rating-adjusted bond returns in 7 different event windows surrounding Hurricane Katrina for the treated bonds and the matched bonds.[4] T-tests report the statistical significance of the differences in bond returns between the treated bonds and the matched bonds. We see that the effect is concentrated in the period of the Hurricane (window 2) and then partially reverts in Window 7 (Dec. 19, 2015 to Jan. 18, 2016).

Next, we perform a multivariate analysis on the relation between bond performances around Hurricane Katrina and the pre-Katrina exposed property insurance ownership. We report the results in Table 4 Panel B. The analysis is at the bond level. The dependent variable is the rating-adjusted cumulative bond returns in excess of the average bond returns in the bond's rating category. The variable of interest is the bond ownership by exposed property & casualty and reinsurance companies at the end of 2005:Q2. We control for the ownership by other types of investors, major bond characteristics including issue amount outstanding, coupon

[4]These windows are as follows: *Before Hurricane Katrina* Window 1: (Aug, 8–21, 2005), *Hurricane Katrina* Window 2: (Aug. 22–Sept. 4, 2015), *Post-Hurricane Katrina* Window 3: (Sept. 5–18, 2015), Window 4: (Sept. 19–Oct. 18, 2015), Window 5: (Oct. 19–Nov. 18, 2015), Window 6: (Nov. 19–Dec. 18, 2015), Window 7: (Dec. 19, 2015–Jan. 18, 2016), and Window 8: (Jan. 19, 2015–Feb. 18, 2016).

TABLE 4

Bond Performances Around Hurricane Katrina

Table 4 reports the results on bond performances around the Hurricane Katrina period. Specifically, for each bond in an event window within the 180 days around Hurricane Katrina, we calculate the risk-adjusted cumulative bond returns in excess of the average bond returns in the bond's rating category. We use 20 monthly credit rating categories from AAA to CCC from the BofA Merrill Lynch index database to estimate the risk-adjusted bond returns. Panel A presents a matching sample analysis. We define "treated" bonds as the ones with the pre-Katrina exposed insurance ownership above the top quintile. For each treated bond, we identify a "matched" bond with the closest propensity matching scores based on major bond characteristics including issue amount outstanding, coupon rate, and time-to-maturity. We report the cumulative rating-adjusted bond returns in 7 different event windows surrounding Hurricane Katrina for the treated bonds and the matched bonds. We test the statistical significance of the differences in bond returns between the treated bonds and the matched bonds using the *t*-test. Panel B reports the results on multivariate regression analysis on the relation between bond performances around Hurricane Katrina and the pre-Katrina exposed property insurance ownership. The analysis is at the bond level. The dependent variable is the rating-adjusted cumulative bond returns in excess of the average bond returns in the bond's rating category. In columns 1–4, we consider 4 event windows surrounding Hurricane Katrina: Window 1 (Aug. 8–21, 2005), Window 2 (Aug. 22–Sept. 18, 2015), Window 3 (Aug. 22–Nov. 18, 2015), and Window 4 (Aug. 22, 2015–Feb 18, 2016) respectively. Credit rating fixed effects and industry fixed effects at 1-digit Standard Industrial Classification (SIC) level are always included. *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively, using robust standard errors with *t*-statistics given in parentheses.

Panel A. Matching Sample Analysis

180 Days Around Hurricane Katrina	Treated Bonds	Matched Bonds	Difference	*t*-Statistics
Pre-Hurricane Katrina				
Window 1: (Aug. 8–21, 2005)	0.11%	0.15%	−0.04%	−0.38
Hurricane Katrina				
Window 2: (Aug. 22–Sept. 4, 2015)	−0.31%	0.15%	−0.46%	−4.14***
Post-Hurricane Katrina				
Window 3: (Sept. 5–18, 2015)	0.05%	0.07%	−0.02%	−0.13
Window 4: (Sept. 19–Oct. 18, 2015)	0.11%	0.13%	−0.02%	−0.09
Window 5: (Oct. 19–Nov. 18, 2015)	−0.15%	−0.09%	−0.06%	−0.26
Window 6: (Nov. 19–Dec. 18, 2015)	−0.14%	0.03%	−0.17%	−1.11
Window 7: (Dec. 19, 2015–Jan. 18, 2016)	0.19%	−0.09%	0.28%	1.75*
Window 8: (Jan. 19, 2015–Feb 18, 2016)	−0.09%	−0.19%	0.10%	0.65

Panel B. Multivariate Regression Analysis

	Dependent Variable: RATING_ADJUSTED_BOND_RETURN			
	Aug. 8–21, 2005	Aug. 22–Sept. 18, 2005	Aug. 22–Nov. 18, 2005	Aug. 22, 2005–Feb. 18, 2006
	1	2	3	4
PROPERTY_INSURANCE_OWNERSHIP AT 2005:Q2 (HIGH EXPOSURE)	0.007	−0.107***	−0.121***	−0.084**
	(0.43)	(−4.09)	(−3.10)	(−2.04)
PROPERTY_INSURANCE_OWNERSHIP AT 2005:Q2 (LOW EXPOSURE)	−0.009	−0.003	−0.003	0.030
	(−0.89)	(−0.14)	(−0.09)	(1.15)
OTHER_INSTITUTIONAL_OWNERSHIP AT 2005:Q2	0.001	0.006	0.007	−0.000
	(0.36)	(1.08)	(0.64)	(−0.01)
log(AMOUNT_OUTSTANDING)	0.001	−0.002	−0.002	0.001
	(0.74)	(−1.34)	(−0.71)	(0.21)
COUPON_RATE	−0.005**	−0.008***	−0.013	−0.012
	(−2.22)	(−3.23)	(−1.20)	(−1.51)
TIME_TO_MATURITY	0.000***	−0.001***	−0.002***	−0.002***
	(3.24)	(−7.11)	(−10.39)	(−6.51)
CALLABILITY	0.002	−0.003	−0.005	−0.008*
	(0.86)	(−1.25)	(−1.00)	(−1.76)
BOND_TURNOVER	0.007*	0.015**	0.006	0.018
	(1.75)	(2.10)	(0.44)	(1.01)
MARKET_TO_BOOK	0.000	0.001	0.005**	0.002
	(0.03)	(0.61)	(2.20)	(0.92)
BOOK_LEVERAGE	−0.004	−0.005	−0.022*	−0.009
	(−1.31)	(−1.01)	(−1.79)	(−1.04)
FIRM_SIZE	0.000	0.000	−0.001	−0.002
	(0.67)	(0.06)	(−0.42)	(−0.98)

(continued on next page)

TABLE 4 (continued)
Bond Performances Around Hurricane Katrina

Panel B. Multivariate Regression Analysis (continued)

	Dependent Variable: RATING_ADJUSTED_BOND_RETURN			
	Aug. 8–21, 2005	Aug. 22–Sept. 18, 2005	Aug. 22–Nov. 18, 2005	Aug. 22, 2005–Feb. 18, 2006
	1	2	3	4
CASH_HOLDING	0.000	0.011***	0.026***	0.015***
	(0.09)	(4.62)	(5.06)	(3.56)
PROFITABILITY	−0.030	0.019	−0.010	−0.008
	(−1.36)	(0.74)	(−0.33)	(−0.21)
Rating fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
R^2	0.037	0.127	0.185	0.107
No. of obs.	1,402	1,402	1,402	1,402

rate, time-to-maturity, callability and institutional bond turnover, and major firm characteristics including market-to-book, book leverage, firm size, cash holding, and profitability.

We consider 4 event windows surrounding Hurricane Katrina: (Aug. 8–21, 2005), (Aug. 22–Sept. 18, 2005), (Aug. 22–Nov. 18, 2005) and (Aug. 22, 2005–Feb. 18, 2006). The results show that the pre-Katrina high-exposure property insurance ownership is not significantly related to bond performances during the 2 weeks before the formation of Katrina. There is instead a strongly negative relationship between the Katrina-period risk-adjusted bond returns and the pre-Katrina bond ownership by exposed property insurance companies. Firms characterized by a 5% higher pre-Katrina high-exposure property insurance ownership experience a drop in bond returns of 53 basis points. This result survives after we include the bond-level controls, firm-level controls, industry fixed effects, and rating fixed effects.

V. Debt Financing Policy

Thus far, we have documented a negative price impact around the Katrina period for the bonds that are held by property (re) insurance companies with high exposure to Katrina. The natural question is whether the condition in the secondary market will be reflected in the primary market. The survey responses from Graham and Harvey (2001) point directly to debt market timing as a motivation in debt financing decisions. Baker, Greenwood, and Wurgler (2003) confirm that firms use debt market conditions in an effort to determine the lowest-cost maturity at which to borrow. Therefore, we now look at whether the spillover effect of Katrina has any real impact on debt financing policies of bond issuers in the post-Katrina period. Given that bond issuing has become more costly in the post-Katrina period for the affected bond issuers, they should have an incentive to switch from issuing bonds to bank financing.

A. Changes in Debt Financing Around Hurricane Katrina: Short-Term Effects

We focus on the short-term impact of pre-Katrina property insurance ownership on the structure of debt financing in the post-Katrina period. We relate the choice of whether to issue bonds or borrow from banks to pre-Katrina property insurance ownership. Here, property insurance ownership is the issue amount weighted property insurance ownership of all the bonds outstanding at 2005:Q2 for each bond issuer.

We report the results in Table 5. We start with some placebo tests in Panel A. One question may be that the fraction of bond to total debt funding is similar beforehand or whether there exists a trend in either persistence or mean-reversion. To address this issue, we examine whether there is a relationship between a firm's pre-Katrina debt financing structure and the pre-Katrina exposed property insurance ownership. In particular, we regress the fraction of bond financing in the period of (Aug. 22, 2003–Aug. 22, 2004) and the one in the period of (Aug. 22, 2004–Aug. 22, 2005) on the pre-Katrina exposed property insurance ownership. We find that the fraction of bond financing prior to Hurricane Katrina (Aug. 22, 2003–Aug. 22, 2004, in columns 1 and 2) and that in (Aug. 22, 2004–Aug. 22, 2005, in columns 3 and 4) are not significantly related to the exposed property insurance ownership. These results show that the bank/bond financing policy is similar beforehand, suggesting that the changes in debt policy after the Hurricane, if any, are not driven by persistence or mean reversion.[5]

We then focus on the change in debt financing in the post-Katrina period. The results are reported in Table 5 Panel B. The dependent variable is the change in the fraction of bond issuances from the year prior to Hurricane Katrina (Aug. 22, 2004–Aug. 22, 2005) to 1 year after Katrina (Aug. 22, 2005–Aug. 22, 2006). Specifically, we first calculate the ratio of bond issuances divided by the sum of bank loans and bond issuances from Aug. 22, 2005, to Aug. 22, 2006. We then subtract the result from the fraction of the bond issuances from Aug. 22, 2004, to Aug. 22, 2005. They display a significantly negative relationship between the fraction of bond financing after Katrina and the pre-Katrina high-exposure property insurance ownership. Firms with a 5% higher pre-Katrina exposure property insurance ownership display a 11% lower fraction of bond financing after the event, which represents a 27% decrease from the unconditional mean. Consistent with the previous findings on bond performances, the effect is still negative but not significant for pre-Katrina low exposure property insurance ownership.[6]

[5]We perform additional test by examining the impact of pre-Katrina property insurance ownership on the change in bank/bond financing choices from (Aug. 22, 2003–Aug. 22, 2004) to (Aug. 22, 2004–Aug. 22, 2005). The unreported results show no relationship between pre-Katrina property insurance ownership and the change in the fraction of bond financing in the year before Hurricane Katrina.

[6]This finding is consistent with the literature that focuses on firm's debt structure and bank/bond choices. For example, Servaes and Tufano (2006) provide evidence based on surveys to CFOs that firms are sophisticated with respect to corporate debt structure, and pricing is the most important element when considering debt policy. Colla, Ippolito, and Li (2013) show that firms effectively manage their debt structure to meet corporate financing needs. Given that in 2005 and 2006 the monetary policy is not tight and the firms in our sample are large firms with low costs of substitution, an exogenous shock to the bond investor base can have a significant impact on a firm's bank/bond financing choices.

In Table 5 Panel C, we present the results of subsample analyses by firms' credit supply conditions. We use the same specification with the inclusion of credit rating fixed effects and industry fixed effects. In columns 1 and 2, we split the sample by the increase in life insurance ownership around Hurricane Katrina from the second quarter of 2005 to the third quarter of 2005 (High if above median; Low

TABLE 5

Changes in Debt Financing Around Hurricane Katrina: Short-Term Effects

Table 5 reports the results on changes in firms' debt financing policies after Hurricane Katrina. The analysis is at the firm level. The dependent variable is the change in the fraction of bond issuances from the year prior to Hurricane Katrina (Aug. 22, 2004–Aug. 22, 2005) to 1 year after Katrina (Aug. 22, 2005–Aug. 22, 2006). Specifically, we first calculate the ratio of the amount of bond issuances divided by the sum of the amount of bank loans and the amount of bond issuances from Aug. 22, 2005 to Aug. 22, 2006. Then we subtract it by the fraction of the amount of bond issuances divided by the sum of the amount of bank loans and the amount of bond issuances from Aug. 22, 2004 to Aug. 22, 2005. Panel A reports placebo tests on firms' debt financing policies before Hurricane Katrina. In columns 1 and 2, the dependent variable is the ratio of the amount of bond issuances divided by the sum of the amount of bank loans and the amount of bond issuances from Aug. 22, 2003 to Aug. 22, 2004. In columns 3 and 4, the dependent variable is the ratio of the amount of bond issuances divided by the sum of the amount of bank loans and the amount of bond issuances from Aug. 22, 2004 to Aug. 22, 2005. The variable of interest is the issue-size weighted average bond ownership by property & casualty and reinsurance companies with high exposure to Hurricane Katrina. We control for ownership by property & casualty insurance companies with low exposure to Hurricane Katrina and ownership by other types of institutional investors. Credit rating fixed effects (20 credit rating categories from AAA to CCC) and industry fixed effects at 1-digit SIC level are included in various specifications. Panel B reports the baseline results. The variable of interest is the issue-size weighted average bond ownership by property & casualty and reinsurance companies with high exposure to Hurricane Katrina. We control for ownership by property & casualty insurance companies with low exposure to Hurricane Katrina and ownership by other types of institutional investors. We include the pre-Katrina fraction of bond issuances as an additional control in column 4. Panel C presents the results of subsample analyses by firms' credit supply conditions. We use the same specification as in Panel B with credit rating fixed effects and industry fixed effects. In columns 1 and 2, we split the sample by the increase in life insurance ownership around Hurricane Katrina from 2005:Q2 to 2005:Q3 (High if above median; Low if below median). In columns 3 and 4, we split the sample by the amount of local banking supply (High if above median; Low if below median). Local banking supply is defined as deposit per asset in the state where the issuing firm is headquartered as of June 2005. For each state, we calculate the ratio of total bank deposits divided by the total market value of stocks headquartered in that state. The data on bank deposits come from FDIC's Summary of Deposits database. FDIC collects deposit balances for commercial and savings banks as of June 30 of each year. We exclude banks specializing in agricultural lending, credit card lending, international lending, mortgage lending, and consumer lending. We include deposits in all bank branches located in each state. *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively, using robust standard errors with *t*-statistics given in parentheses.

Panel A. Placebo Test

	Dependent Variable: BOND/(BOND+BANK)			
	Aug. 22, 2003–Aug. 22, 2004		Aug. 22, 2004–Aug. 22, 2005	
	1	2	3	4
PROPERTY_INSURANCE_OWNERSHIP AT 2005:Q2 (HIGH EXPOSURE)	−1.690 (−1.49)	−1.161 (−0.85)	0.373 (0.29)	0.197 (0.14)
PROPERTY_INSURANCE_OWNERSHIP AT 2005:Q2 (LOW EXPOSURE)	−0.132 (−0.15)	1.102 (1.15)	−1.223 (−1.64)	−1.352* (−1.65)
OTHER_INSTITUTIONAL_OWNERSHIP AT 2005:Q2	−0.422*** (−3.14)	−0.210 (−1.36)	−0.371*** (−2.70)	−0.260 (−1.60)
INSTITUTIONAL_BOND_TURNOVER	−0.033 (−0.10)	−0.434 (−1.36)	1.038*** (2.89)	1.029*** (2.64)
FIRM_SIZE	0.010 (0.62)	0.046** (2.14)	0.031* (1.86)	0.043* (1.84)
MARKET_TO_BOOK	−0.011 (−0.32)	0.019 (0.54)	0.102*** (3.78)	0.088*** (2.71)
BOOK_LEVERAGE	0.535*** (4.25)	0.361*** (2.91)	0.167 (1.20)	0.170 (1.15)
PROFITABILITY	0.054 (0.15)	0.324 (1.01)	−0.520 (−1.42)	−0.434 (−1.07)
CASH_HOLDING	0.093 (0.37)	−0.129 (−0.56)	−0.365 (−1.61)	−0.334 (−1.36)
Industry fixed effects	Yes	Yes	Yes	Yes
Rating fixed effects	–	Yes	–	Yes
R^2	0.181	0.273	0.165	0.199
No. of obs.	355	355	355	355

(continued on next page)

TABLE 5 (continued)

Changes in Debt Financing Around Hurricane Katrina: Short-Term Effects

Panel B. Baseline Results

	Dependent Variable: Δ BOND/(BOND+BANK)			
	1	2	3	4
PROPERTY_INSURANCE_OWNERSHIP AT 2005:Q2 (HIGH EXPOSURE)	−3.156*** (−2.85)	−3.343** (−2.58)	−3.134** (−2.55)	−2.543*** (−3.19)
PROPERTY_INSURANCE_OWNERSHIP AT 2005:Q2 (LOW EXPOSURE)	−0.475 (−0.54)	−0.417 (−0.46)	−0.437 (−0.49)	−0.837 (−1.11)
OTHER_INSTITUTIONAL_OWNERSHIP AT 2005:Q2	0.211 (1.39)	0.292* (1.75)	0.330* (1.88)	0.043 (0.28)
INSTITUTIONAL_BOND_TURNOVER	−0.932** (−2.59)	−0.957** (−2.47)	−1.002** (−2.56)	−0.230 (−0.68)
FIRM_SIZE	0.013 (0.85)	0.027 (1.05)	0.033 (1.28)	0.039* (1.74)
MARKET_TO_BOOK	0.024 (0.65)	0.027 (0.63)	0.021 (0.47)	0.041 (1.08)
BOOK_LEVERAGE	−0.218 (−1.43)	−0.313* (−1.94)	−0.337** (−2.09)	−0.277** (−2.00)
PROFITABILITY	−0.010 (−0.03)	0.265 (0.64)	0.271 (0.65)	−0.264 (−0.74)
CASH_HOLDING	−0.171 (−0.66)	−0.287 (−1.07)	−0.249 (−0.86)	−0.343 (−1.37)
YEAR 2004: BOND/(BOND+BANK)				−0.730*** (−12.58)
Rating fixed effects	–	Yes	Yes	Yes
Industry fixed effects	–	–	Yes	Yes
R^2	0.057	0.102	0.129	0.419
No. of obs.	385	385	385	385

Panel C. Subsample Analyses by Bond/Bank Credit Supply

	Dependent Variable: Δ BOND/(BOND+BANK)			
	Increase in Life Insurance Ownership		Local Bank Credit Supply	
	High	Low	High	Low
	1	2	3	4
PROPERTY_INSURANCE_OWNERSHIP AT 2005:Q2 (HIGH EXPOSURE)	−1.799 (−0.90)	−4.329*** (−2.75)	−3.719*** (−2.77)	−2.320 (−0.92)
PROPERTY_INSURANCE_OWNERSHIP AT 2005:Q2 (LOW EXPOSURE)	−0.766 (−0.60)	−1.947 (−1.34)	−1.519 (−1.12)	−0.520 (−0.37)
OTHER_INSTITUTIONAL_OWNERSHIP AT 2005:Q2	0.536* (1.85)	0.209 (0.78)	0.511* (1.86)	0.213 (0.69)
INSTITUTIONAL_BOND_TURNOVER	−0.971* (−1.90)	−1.020* (−1.72)	−0.586 (−1.05)	−1.339** (−1.98)
FIRM_SIZE	0.026 (0.68)	0.039 (0.89)	0.029 (0.69)	0.059 (1.41)
MARKET_TO_BOOK	−0.001 (−0.01)	0.092 (1.33)	0.110 (1.39)	−0.016 (−0.30)
BOOK_LEVERAGE	−0.289 (−1.43)	−0.547** (−2.10)	−0.403 (−1.23)	−0.412 (−1.59)
PROFITABILITY	0.083 (0.09)	0.387 (0.79)	0.263 (0.47)	0.728 (1.08)
CASH_HOLDING	0.609* (1.66)	−0.893** (−2.09)	−0.362 (−0.77)	−0.471 (−1.02)
Rating fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
R^2	0.231	0.178	0.265	0.181
No. of obs.	182	189	173	185

if below median). In columns 3 and 4, we split the sample by the amount of local banking supply (High if above median; Low if below median). Local banking supply is defined as deposit per asset in the state where the issuing firm is headquartered as of June 2005.[7] We find that the effect is concentrated in firms with lower increase in life insurance bond ownership, suggesting that firms have less incentive to switch to bank financing if the affected bonds are picked up by life insurance companies rather than by other types of bond investors. This result is consistent with the fact that life insurance companies suffer less for extreme natural disaster-related shocks and therefore indicate more-stable bond supply conditions. Alternatively, if the corporate bonds held by Katrina-exposed insurance companies are sold to other property insurance companies or mutual funds with more credit supply uncertainty, the bond issuers have stronger incentives to switch to bank financing. These results suggest that firms react to the pressure in the bond market by borrowing from banks.

On the other hand, access to bank financing is not equally easy for all the firms. The literature documents evidence that firm location impacts access to bank financing (Butler and Cornaggia (2011), Becker (2007), Lemmon and Roberts (2010), and Leary (2009)). Therefore, the impact of the bond sales of insurance companies on firms' debt policies should be affected by the availability of bank financing. The higher the availability, the easier it is for firms to switch from bond to bank financing. Indeed, we find that that affected firms tend to switch to bank financing if there is ample bank credit supply in the local region.

A related concern may be that the observed decrease in the fraction of bond financing is solely because the affected bond issuers refrain from issuing bonds rather than substituting bonds with bank loans. We therefore look at the amounts of bond issuances and bank borrowings separately. Consistent with the bank/bond substitution claim, unreported results document a significantly negative relationship between pre-Katrina high-exposure property insurance ownership and the amount of post-Katrina *bond* issuances. Conversely, there is a significantly positive relationship between pre-Katrina high-exposure property insurance ownership and the amount of post-Katrina *bank* borrowings, confirming that in response to the Katrina shock, the affected bond issuers tend to substitute away from bonds and rely more on bank loans.

B. Changes in Debt Financing Around Hurricane Katrina: Long-Term Effects

The next important question is whether such behavior has long-term implications for the firm's debt financing structure. If the switch to bank financing is temporary and there is no persistent effect, we should observe a mean reversion in bank/bond financing, and there should be no significant cumulative effects.

[7]For each state, we calculate the ratio of total bank deposits divided by the total market value of stocks headquartered in that state. The data come from FDIC's Summary of Deposits database. FDIC collects deposit balances for commercial and savings banks as of June 30 of each year. We exclude banks specializing in agricultural lending, credit card lending, international lending, mortgage lending, and consumer lending.

Alternatively, if credit supply conditions are important considerations of a firm's debt policy, then the Katrina shock may increase the perceived uncertainty in the financing conditions of the affected bond issuers and raise their risk attitude against bond financing in the long term.

To address this question, we start by focusing on the cumulative changes in the fraction of bond financing in the 2 years and the 3 years after Hurricane Katrina. In Table 6 Panel A, we report the results of regressing the changes in the percentage of bond financing over total (bond and bank-based) financing on the insurance ownership before Katina and the other control variables defined previously. In particular, in columns 1 and 3, the dependent variable is the change in the ratio of bond issuances from the year prior to Hurricane Katrina (Aug. 22, 2004–Aug. 22, 2005) to the 2 years after Katrina (Aug. 22, 2005–Aug. 22, 2007). Specifically, we first calculate the ratio of the amount of bond issuances divided by the sum of the amount of bank loans and the amount of bond issuances from Aug. 22, 2005, to Aug. 22, 2007. We then subtract from the result the fraction of the amount of bond issuances divided by the sum of the amount of bank loans and the amount of bond issuances from Aug. 22, 2004, to Aug. 22, 2005. In columns 2 and 4, the dependent variable is calculated similarly as the change in the ratio of bond issuances from the year prior to Hurricane Katrina (Aug. 22, 2004–Aug. 22, 2005) to the 3 years after Katrina (Aug. 22, 2005–Aug. 22, 2008).

The results show a strong negative effect of Karina on the fraction of public bond financing by the corporations over both 2 and 3 years after Hurricane Katrina. The affected firms shift from bond financing to bank loans at least in the next 3 years after Hurricane Katrina. This evidence suggests that firms change their debt financing behavior in the long term after they become more aware that their bondholders can suffer large fire sales that adversely affect bond prices.

As a robustness check to assess whether there is persistence in the policy of debt financing, we also examine the incremental changes from (Aug. 22, 2005–Aug. 22, 2006) to (Aug. 22, 2006–Aug. 22, 2007) and from (Aug. 22, 2006–Aug. 22, 2007) to (Aug. 22, 2007–Aug. 22, 2008). We report the results in Table 6 Panel B. Across the different windows, the results confirm the previous finding on the cumulative effects that there is no significant mean reversion after the initial shift toward bank financing after the hurricane. There is in fact an incremental shift toward bank financing for Katrina-affected firms in the second year beyond the initial change in the first year after Hurricane Katrina. However, there is no significant incremental effect in the third year after the hurricane. These results suggest that the shift does not revert in the long term.

C. Changes in Maturity of Debt Financing After Katrina

Next, we focus on the changes in the maturity structure of debt financing. We test whether the induced reallocation from bonds to loans translates into a change in the debt maturity structure of the firm. We explore the impact of exposed property insurance ownership, as of the second quarter of 2005, on the changes in the maturity of debt financing after Katrina. In particular, we regress the change in

the debt maturity on the level of exposed property insurance ownership before Katrina (at the second quarter of 2005) and on a set of control variables. Debt maturity is the natural logarithm of the size (the offering amount for bonds and borrowing amount for bank loans) weighted maturity between bonds and bank loans in a given period. We only include bond issuances and bank loans with maturities more than 1 year.

TABLE 6

Changes in Debt Financing Around Hurricane Katrina: Long-Term Effects

Table 6 reports the result on long-term effects on firms' debt financing choices. We examine both the cumulative effects as well as the incremental effects during the 3 years after Hurricane Katrina. Panel A reports the cumulative effects on the changes in firms' debt financing choices. We focus on the changes in the fraction of bond during the 2 years and the 3 years after Hurricane Katrina. In columns 1 and 3, the dependent variable is the change in the ratio of bond issuances from the year prior to Hurricane Katrina (Aug. 22, 2004–Aug. 22, 2005) to the 2 years after Katrina (Aug. 22, 2005–Aug. 22, 2007). We first calculate the ratio of the amount of bond issuances divided by the sum of bank loans and bond issuances from Aug. 22, 2005 to Aug. 22, 2007. Then we subtract it by the fraction of the amount of bond issuances divided by the sum of bank loans and bond issuances from Aug. 22, 2004 to Aug. 22, 2005. In columns 2 and 4, the dependent variable is calculated similarly as the change in the ratio of bond issuances from the year prior to Hurricane Katrina (Aug. 22, 2004–Aug. 22, 2005) to the 3 years after Katrina (Aug. 22, 2005–Aug. 22, 2008). We include the pre-Katrina fraction of bond issuances (Aug. 22, 2004–Aug. 22, 2005) as an additional control in columns 3 and 4. Panel B reports the incremental changes in firms' debt financing in the years after Hurricane Katrina. In columns 1 and 2, the dependent variable is the change in the fraction of bond issuances in the second year after Hurricane Katrina (i.e., from (Aug. 22, 2005–Aug. 22, 2006) to (Aug. 22, 2006–Aug. 22, 2007)). In columns 3 and 4, the dependent variable is the change in the fraction of bond issuances in the third year after Hurricane Katrina (i.e., from (Aug. 22, 2006–Aug. 22, 2007) to (Aug. 22, 2007–Aug. 22, 2008)). The variable of interest is the issue-size weighted average bond ownership by property & casualty and reinsurance companies with high exposure to Hurricane Katrina. We control for ownership by property & casualty insurance companies with low exposure to Hurricane Katrina and ownership by other types of institutional investors. We always include the lagged fraction of bond issuances as an additional control. Credit rating fixed effects (20 rating categories from AAA to CCC) and industry fixed effects at 1-digit SIC level are included in various specifications. *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively, using robust standard errors with *t*-statistics given in parentheses.

Panel A. Cumulative Effects

	Dependent Variable: Δ BOND/(BOND+BANK)			
	2 Years	3 Years	2 Years	3 Years
	1	2	3	4
PROPERTY_INSURANCE_OWNERSHIP AT 2005:Q2 (HIGH EXPOSURE)	−3.178*** (−2.74)	−2.641* (−1.95)	−2.615*** (−3.90)	−2.046*** (−2.65)
PROPERTY_INSURANCE_OWNERSHIP AT 2005:Q2 (LOW EXPOSURE)	0.730 (0.85)	0.957 (1.04)	0.348 (0.55)	0.555 (0.83)
OTHER_INSTITUTIONAL_OWNERSHIP AT 2005:Q2	0.389** (2.41)	0.390** (2.29)	0.116 (0.87)	0.102 (0.76)
INSTITUTIONAL_BOND_TURNOVER	−1.138*** (−3.09)	−1.147*** (−3.11)	−0.401 (−1.29)	−0.370 (−1.21)
FIRM_SIZE	0.032 (1.33)	0.036 (1.48)	0.038* (1.84)	0.042** (2.06)
MARKET_TO_BOOK	0.008 (0.18)	0.015 (0.33)	0.027 (0.73)	0.035 (0.99)
BOOK_LEVERAGE	−0.259* (−1.75)	−0.233 (−1.52)	−0.201 (−1.63)	−0.172 (−1.40)
PROFITABILITY	0.242 (0.58)	0.380 (0.92)	−0.269 (−0.78)	−0.159 (−0.46)
CASH_HOLDING	0.012 (0.04)	0.038 (0.13)	−0.077 (−0.31)	−0.057 (−0.22)
YEAR 2004: BOND/(BOND+BANK)			−0.696*** (−13.68)	−0.734*** (−14.63)
Rating fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
R^2	0.057	0.102	0.129	0.419
No. of obs.	385	385	385	385

(continued on next page)

TABLE 6 (continued)

Changes in Debt Financing Around Hurricane Katrina: Long-Term Effects

Panel B. Incremental Effects

	Dependent Variable: Δ BOND/(BOND+BANK)			
	(Aug. 22, 2005, Aug. 22, 2006) - (Aug. 22, 2006, Aug. 22, 2007)		(Aug. 22, 2006, Aug. 22, 2007) - (Aug. 22, 2007, Aug. 22, 2008)	
	1	2	3	4
PROPERTY_INSURANCE_OWNERSHIP AT 2005:Q2 (HIGH EXPOSURE)	−4.055*** (−3.40)	−3.870*** (−2.91)	0.755 (0.66)	−0.016 (−0.01)
PROPERTY_INSURANCE_OWNERSHIP AT 2005:Q2 (LOW EXPOSURE)	0.964 (0.86)	1.407 (1.16)	−2.406* (−1.88)	−1.989 (−1.57)
OTHER_INSTITUTIONAL_OWNERSHIP AT 2005:Q2	−0.017 (−0.12)	0.154 (0.96)	−0.091 (−0.48)	0.106 (0.54)
INSTITUTIONAL_BOND_TURNOVER	0.258 (0.77)	0.183 (0.53)	−0.483 (−1.24)	−0.671 (−1.55)
FIRM_SIZE	0.057*** (3.59)	0.094*** (4.00)	0.017 (0.79)	0.062* (1.91)
MARKET_TO_BOOK	0.047 (1.13)	0.088* (1.86)	0.067 (1.19)	0.095 (1.48)
BOOK_LEVERAGE	0.292** (2.25)	0.226* (1.69)	0.392*** (2.73)	0.382** (2.58)
PROFITABILITY	−1.489*** (−4.14)	−1.352*** (−3.63)	−0.363 (−0.63)	−0.349 (−0.61)
CASH_HOLDING	0.176 (0.68)	0.079 (0.32)	−0.508 (−1.50)	−0.635* (−1.67)
LAGGED_BOND/(BOND+BANK)	−0.908*** (−14.37)	−0.901*** (−14.02)	−0.812*** (−12.27)	−0.858*** (−11.97)
Industry fixed effects	Yes	Yes	Yes	Yes
Rating fixed effects	–	Yes	–	Yes
R^2	0.465	0.501	0.479	0.523
No. of obs.	314	314	240	240

We report the results in Table 7. In Panels A and B, we focus on the short-term effects. In Panel A, the dependent variable is the overall change in debt maturity from the year prior to Hurricane Katrina (Aug. 22, 2004–Aug. 22, 2005) to 1 year after Katrina (Aug. 22, 2005–Aug. 22, 2006). The variable of interest is the issue amount weighted average bond ownership by property & casualty and reinsurance companies with high exposure to Hurricane Katrina. We control for ownership by property & casualty insurance companies with low exposure to Hurricane Katrina and ownership by other types of institutional investors.

The results in Table 7 Panel A show a significantly negative relationship between the change in debt maturity and the pre-Katrina exposed property insurance ownership. Firms with a 5% higher pre-Katrina exposed property insurance ownership display a 19% lower debt maturity after the event when compared to the unconditional mean.

Another interesting question is whether the change in debt maturity is simply a manifestation of the switch to bank loans or there exists an additional dimension of adjustment. Bank loans normally could have a 3–5-year maturity, while most public bonds are longer term such that the change in debt maturity is just corroborating the

earlier results that bank loans appear to substitute for bonds. To address this issue, we separately examine the change in bond maturity and the change in bank loan maturity. In Table 7 Panel B, we consider the maturity of bond debt (columns 1 and 2) and the maturity of bank debt (columns 3 and 4). The results in Panel B show that

TABLE 7

Changes in Debt Maturity Around Hurricane Katrina

Table 7 reports the results on changes in the maturities in firms' debt financing after Hurricane Katrina. The analysis at the firm level. Bond maturity is the offering amount weighted maturity among all of the bond issuances in a given period. Bank loan maturity is the borrowing amount weighted loan maturity among all of the bank loans in a given period. We only include bond issues and bank loans with maturities more than 1 year. Panel A reports the change in the overall maturity of debt financing around Hurricane Katrina. The dependent variable is the change in debt maturity from the year prior to Hurricane Katrina (Aug. 22, 2004–Aug. 22, 2005) to 1 year after Katrina (Aug. 22, 2005–Aug. 22, 2006). The variable of interest is the issue-size weighted average bond ownership by property & casualty and reinsurance companies with high exposure to Hurricane Katrina. We control for the ownership by property & casualty insurance companies with low exposure to Hurricane Katrina and ownership by other types of institutional investors. We include the pre-Katrina debt maturity as an additional control in column 4. Panel B reports the change in bond and bank loan maturity around Hurricane Katrina. In columns 1 and 2, the dependent variable is the change in bond maturity from the year prior to Hurricane Katrina (Aug. 22, 2004–Aug. 22, 2005) to 1 year after Katrina (Aug. 22, 2005–Aug. 22, 2006). In columns 3 and 4, the dependent variable is the change in bank loan maturity from the year prior to Hurricane Katrina (Aug. 22, 2004–Aug. 22, 2005) to 1 year after Katrina (Aug. 22, 2005–Aug. 22, 2006). The variable of interest is the issue-size weighted average bond ownership by property & casualty and reinsurance companies with high exposure to Hurricane Katrina. We control for the ownership by property & casualty insurance companies with low exposure to Hurricane Katrina and ownership by other types of institutional investors. We include the pre-Katrina bond and bank loan maturity as additional controls. Panel C reports long-term effects on the maturities of debt financing. We focus on the changes in debt financing during the 2 years and the 3 years after Hurricane Katrina. In columns 1 and 3, the dependent variable is the change in debt maturity from the year prior to Hurricane Katrina (Aug. 22, 2004–Aug. 22, 2005) to the 2 years after Katrina (Aug. 22, 2005–Aug. 22, 2007). In columns 2 and 4, the dependent variable is the change in debt maturity from the year prior to Hurricane Katrina (Aug. 22, 2004–Aug. 22, 2005) to the 3 years after Katrina (Aug. 22, 2004–Aug. 22, 2008). We include the pre-Katrina debt maturity (Aug. 22, 2004–Aug. 22, 2005) as an additional control in columns 3 and 4. Credit rating fixed effects (20 rating categories from AAA to CCC) and industry fixed effects at 1-digit SIC level are always included in the regressions. *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively, using robust standard errors with *t*-statistics given in parentheses.

Panel A. Changes in Debt Maturity Around Hurricane Katrina

	Dependent Variable: Δ DEBT_MATURITY			
	1	2	3	4
PROPERTY_INSURANCE_OWNERSHIP AT 2005:Q2 (HIGH EXPOSURE)	−3.709*** (−3.16)	−3.377** (−2.43)	−3.407** (−2.59)	−3.312*** (−2.98)
PROPERTY_INSURANCE_OWNERSHIP AT 2005:Q2 (LOW EXPOSURE)	−1.030 (−0.74)	−0.011 (−0.01)	0.098 (0.07)	0.091 (0.07)
OTHER_INSTITUTIONAL_OWNERSHIP AT 2005:Q2	0.278 (1.26)	0.382 (1.47)	0.477* (1.79)	0.544** (2.25)
INSTITUTIONAL_BOND_TURNOVER	−1.063** (−2.28)	−1.186** (−2.43)	−1.171** (−2.33)	−0.464 (−1.12)
FIRM_SIZE	0.026 (1.09)	0.093** (2.41)	0.099** (2.53)	0.079** (2.35)
MARKET_TO_BOOK	0.034 (0.74)	0.099* (1.79)	0.111** (2.08)	0.122** (2.55)
BOOK_LEVERAGE	0.028 (0.15)	−0.129 (−0.58)	−0.081 (−0.36)	−0.218 (−1.06)
PROFITABILITY	−0.253 (−0.62)	−0.098 (−0.21)	0.058 (0.13)	−0.142 (−0.34)
CASH_HOLDING	−0.019 (−0.06)	−0.213 (−0.61)	−0.327 (−0.90)	−0.638** (−2.04)
YEAR 2004: DEBT_MATURITY				−0.798*** (−3.99)
Rating fixed effects	–	Yes	Yes	Yes
Industry fixed effects	–	–	Yes	Yes
R^2	0.048	0.113	0.135	0.345
No. of obs.	342	342	342	342

(continued on next page)

TABLE 7 (continued)

Changes in Debt Maturity Around Hurricane Katrina

Panel B. Changes in Bond and Bank Loan Maturity Around Hurricane Katrina

	Dependent Variable: Δ MATURITY from (Aug. 22 2004–Aug. 22, 2005) to (Aug. 22 2005– Aug. 22, 2006)			
	Bonds		Bank Loans	
	1	2	3	4
PROPERTY_INSURANCE_OWNERSHIP AT 2005:Q2 (HIGH EXPOSURE)	−14.804** (−2.57)	−12.470** (−2.46)	0.966** (2.15)	1.103* (1.95)
PROPERTY_INSURANCE_OWNERSHIP AT 2005:Q2 (LOW EXPOSURE)	2.173 (0.73)	6.164* (1.90)	−0.408 (−0.76)	−0.214 (−0.39)
OTHER_INSTITUTIONAL_OWNERSHIP AT 2005:Q2	0.282 (0.73)	0.329 (0.69)	0.004 (0.04)	−0.056 (−0.54)
INSTITUTIONAL_BOND_TURNOVER	−0.159 (−0.29)	−0.054 (−0.09)	−0.313 (−1.20)	−0.319 (−1.25)
FIRM_SIZE	−0.027 (−0.86)	0.107*** (2.72)	−0.029 (−1.64)	−0.014 (−0.72)
MARKET_TO_BOOK	0.048 (1.56)	0.163*** (3.79)	−0.065 (−1.13)	−0.043 (−0.85)
BOOK_LEVERAGE	0.312 (1.19)	0.213 (0.70)	0.182 (1.34)	0.207* (1.80)
PROFITABILITY	0.627 (1.35)	0.597 (1.22)	0.296 (0.81)	0.239 (0.60)
CASH_HOLDING	−0.091 (−0.23)	−0.078 (−0.19)	−0.123 (−0.55)	−0.208 (−0.95)
YEAR 2004: BOND_MATURITY	−0.573*** (−5.59)	−0.506*** (−4.74)		
YEAR 2004: LOAN_MATURITY			−0.666*** (−10.70)	−0.710*** (−11.67)
Industry fixed effects	Yes	Yes	Yes	Yes
Rating fixed effects	–	Yes	–	Yes
R^2	0.307	0.454	0.518	0.569
No. of obs.	170	170	233	233

Panel C. Long-Term Effects

	Dependent Variable: Δ DEBT_MATURITY			
	2 Years	3 Years	2 Years	3 Years
	1	2	3	4
PROPERTY_INSURANCE_OWNERSHIP AT 2005:Q2 (HIGH EXPOSURE)	−3.893*** (−3.19)	−3.241** (−2.31)	−3.815*** (−3.97)	−3.207*** (−2.73)
PROPERTY_INSURANCE_OWNERSHIP AT 2005:Q2 (LOW EXPOSURE)	1.254 (0.96)	1.236 (0.94)	0.674 (0.62)	0.689 (0.65)
OTHER_INSTITUTIONAL_OWNERSHIP AT 2005:Q2	0.630*** (2.70)	0.488** (2.14)	0.532*** (2.68)	0.384** (2.08)
INSTITUTIONAL_BOND_TURNOVER	−1.308** (−2.56)	−0.990** (−2.10)	−0.640 (−1.56)	−0.376 (−0.96)
FIRM_SIZE	0.089** (2.45)	0.100*** (2.91)	0.059* (1.91)	0.071** (2.42)
MARKET_TO_BOOK	0.083 (1.64)	0.106** (2.01)	0.084* (1.81)	0.105** (2.43)
BOOK_LEVERAGE	−0.354* (−1.82)	−0.315* (−1.71)	−0.319* (−1.81)	−0.284* (−1.77)
PROFITABILITY	−0.206 (−0.46)	0.136 (0.33)	−0.466 (−1.19)	−0.106 (−0.28)
CASH_HOLDING	−0.420 (−1.18)	−0.299 (−0.82)	−0.750** (−2.57)	−0.658** (−2.15)
YEAR 2004: DEBT_MATURITY			−1.101*** (−9.14)	−1.089*** (−9.20)
Rating fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
R^2	0.171	0.164	0.449	0.446
No. of obs.	342	342	342	342

when we break down the analysis by type of debt, there is a sizable reduction in the maturity of public debt, while the maturity of bank debt does in fact increase.

These results document additional dimensions of maturity adjustments. In the case of bond issuance, there is a shortening of the bond maturity. This aspect can be explained by the fact that longer maturity bonds are less liquid than are short maturity bonds (Bao, Pan, and Wang (2011)); therefore, the negative price impact on them will be stronger.[8] In the case of bank loans, instead, the affected firms tend to switch from bonds to bank loans and, in the meantime, because bonds generally have longer maturity than bank loans do, these firms tend to ask for longer maturity loans. These results are overall consistent with the substitution effect from bonds to bank loans. The shortening of the maturity in the bond financing and the reallocation toward bank loans result in an overall reduction in the maturity of debt financing.

In Table 7 Panel C, we look at the long-term effects of the pre-Katrina exposed insurance ownership on the changes in maturities of debt financing. We focus on the changes in debt financing in the 2 years and the 3 years after Hurricane Katrina. In columns 1 and 3, the dependent variable is the change in debt maturity from the year prior to Hurricane Katrina (Aug. 22, 2004–Aug. 22, 2005) to the 2 years after Katrina (Aug. 22, 2005–Aug. 22, 2007). In columns 2 and 4, the dependent variable is the change in debt maturity from the year prior to Hurricane Katrina (Aug. 22, 2004–Aug. 22, 2005) to the 3 years after Katrina (Aug. 22, 2005–Aug. 22, 2008). We include the pre-Katrina debt maturity (Aug. 22, 2004–Aug. 22, 2005) as an additional control in columns 3 and 4.

The results are consistent with the short-term ones. There is a significantly negative relationship between the change in debt maturity and the pre-Katrina exposed property insurance ownership. Firms with high pre-Katrina exposed property insurance ownership display a 17% lower debt maturity after the event when compared to the unconditional mean. Overall, these results show a persistent impact of the Katrina event on the maturity of firms' debt financing.

D. Changes in Capital Structure After Katrina

Finally, we examine the effect on the capital structure as a whole. If bank financing fully replaces the bond financing, we expect no changes in the capital structure. However, if the substitution by bank debt of bond debt is not sufficient, we should observe a drop in firm leverage. We therefore focus on the change of capital structure after Katrina and how that change is related to pre-Katrina property insurance ownership.

We report the results in Table 8. In columns 1–4, the dependent variable is the change in book leverage from 2004 to 2005, 2006, 2007, and 2008. In all the specifications across the different periods, we find that the coefficient on the pre-Katrina exposed property insurance ownership is not significant, suggesting

[8]In unreported analyses, we find consistent results that the negative impact on risk-adjusted bond returns are indeed stronger for long-term bonds.

TABLE 8

Changes in Capital Structure after Hurricane Katrina

Table 8 reports the results of the impact on firms' capital structure in the post-Katrina period. In columns 1–4, the dependent variable is the change in book leverage from 2004 to 2005, 2006, 2007, and 2008, respectively. The variable of interest is the issue-size weighted average bond ownership by property & casualty and reinsurance companies with high exposure to Hurricane Katrina. We include institutional bond turnover (issue-size weighted average bond turnover), firm size, market-to-book, profitability, and cash holdings as firm controls. All firm level controls are taken at the beginning of 2005. Credit rating fixed effects (20 rating categories from AAA to CCC) and industry fixed effects at 1-digit SIC level are included in all specifications. *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively, using robust standard errors with *t*-statistics given in parentheses.

	Dependent Variable : Δ BOOK_LEVERAGE			
	2005	2006	2007	2008
	1	2	3	4
PROPERTY_INSURANCE_OWNERSHIP AT 2005:Q2 (HIGH EXPOSURE)	−0.003	0.014	−0.141	−0.082
	(−0.04)	(0.11)	(−0.89)	(−0.51)
PROPERTY_INSURANCE_OWNERSHIP AT 2005:Q2 (LOW EXPOSURE)	−0.088	−0.142	−0.107	−0.280
	(−1.02)	(−1.24)	(−0.79)	(−1.58)
OTHER_INSTITUTIONAL_OWNERSHIP AT 2005:Q2	−0.000	0.001	0.029	0.039
	(−0.03)	(0.07)	(1.06)	(1.05)
INSTITUTIONAL_BOND_TURNOVER	0.057	0.117**	0.075	0.225***
	(1.52)	(2.35)	(1.35)	(3.29)
FIRM_SIZE	−0.007**	−0.005	−0.002	0.003
	(−2.49)	(−1.44)	(−0.45)	(0.59)
MARKET_TO_BOOK	−0.161	−0.037	−0.019	0.108
	(−1.18)	(−0.29)	(−0.23)	(0.90)
PROFITABILITY	−0.106***	−0.128**	−0.083	−0.234***
	(−2.94)	(−2.47)	(−1.35)	(−3.05)
CASH_HOLDING	0.017	0.006	0.012	0.011
	(1.47)	(0.60)	(0.99)	(0.90)
YEAR 2004: BOOK_LEVERAGE	−0.132***	−0.153***	−0.226***	−0.296***
	(−4.56)	(−4.99)	(−7.05)	(−7.25)
Rating fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
R^2	0.142	0.293	0.453	0.456
No. of obs.	410	394	320	308

that, for firms affected by the spillover effects of Katrina, the substitution from bonds to bank loans is sufficient for the amount of borrowing such that the overall capital structure is not affected.

VI. Robustness Checks

In this section, we consider several robustness checks of the main specifications. The results are reported in Table A1 of the Supplementary Material. We first consider an alternative identification of insurance companies with high business exposure to Hurricane Katrina (Panel A). We collect the information on paid losses of insurance companies from the National Association of Insurance Commissioners (NAIC) database. We identify the top 10 property and casualty insurance companies with the largest amount of paid losses in the third quarter of 2005, which can be matched into the Lipper/eMAXX database as the managing firms. We repeat the same analyses as the main tables and report the results accordingly.

Next, the bonds that suffer from Katrina might actually be issued by firms that belong to the same financial conglomerates affiliated with the affected property

insurance companies or by firms that are located in the region directly affected by Hurricane Katrina. To address this potential issue, we perform a subsample analysis where we focus on either the subsample of bonds issued by the firms not headquartered in the affected region or the subsample of bonds issued excluding insurance companies. In the former case, we exclude the firms headquartered in Alabama, Florida, Louisiana, Mississippi, and Texas (Table A1, Panel B). In the latter case, we exclude the firm in the insurance industry (Table A1, Panel C). For brevity, we only report results on the variable of interest, namely, the pre-Katrina bond ownership by property insurance companies with high exposure to Hurricane Katrina at the end of the second quarter of 2005.

Across all the robustness checks, the results are similar to the previous ones, suggesting that our findings are not driven by bonds issued by insurance companies or by firms located in the region that may be directly affected by Katrina. We interpret these findings as clear evidence that Hurricane Katrina generates an externality spillover effect on the behavior of corporate bonds and on the debt financing policy of bond issuers through the channel of property insurance companies, even if these firms are not directly affected by the hurricane.

VII. Conclusion

We study how a temporary shock to the ability to finance in the bond market induces a persistent substitutability in debt composition. We use the spillover effects of Hurricane Katrina on corporate bonds through the channel of bond ownership by property and reinsurance companies. We find that property and reinsurance companies begin to liquidate their bond holdings after Katrina, driven by those companies with high Katrina exposure. We then study how this behavior affects the bank/bond financing structure of bond issuers, depending on their pre-Katrina property insurance bond ownership. We find a significantly negative relationship between the fraction of bond financing after Katrina and the pre-Katrina high-exposure property insurance ownership. Moreover, there is a significant reduction in debt maturity due to the composition change between bonds and bank loans and a shortening of bond maturity. Interestingly, there is no significant effect on changes of capital structure, suggesting that the substitution from bonds to bank loans is sufficient for the amount of borrowing.

Our work contributes to the large natural disaster literature, indicating that such disasters can generate significant externality effects on corporate bonds and bond issuers through the channel of financial intermediaries such as property & casualty and reinsurance companies. These findings contribute to the literature with respect to the price impact of liquidity shocks in the bond market and with respect to how firms manage their debt structure when facing exogenous shocks.

Supplementary Material

To view supplementary material for this article, please visit http://dx.doi.org/10.1017/S0022109020000459.

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