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Do Bond Spreads Show Evidence of Too Big To Fail Effects?

Evidence from 2009–2013 Among US Bank Holding Companies

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BACKGROUND ON THE STUDY

Ensuring that a subset of financial firms do not benefit from the perception that they are "too big to fail" (TBTF) is an important, frequently stated goal of ongoing financial regulatory reform efforts. Robustly assessing the empirical evidence of whether market perceptions of TBTF status reduce funding costs for some institutions is challenging but critical. As new financial regulations intended to address TBTF take effect, ongoing measurements of funding differentials related to TBTF can serve as a scorecard for financial reform efforts to date, and a useful indicator of whether alternative reforms may be needed to succeed in the battle against TBTF.

This working paper describes one result from a broader effort to review and update the empirical evidence of TBTF among US banking institutions. It follows our working paper, "Do Deposit Rates Show Evidence of Too Big to Fail Effects?" (2014). Our aim is to build on the most promising research on funding costs to develop a robust view of TBTF perceptions using the latest available information.

This study was sponsored by The Clearing House Association. All findings below are solely our own.

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Executive Summary

Analysis of so-called "too big to fail" (TBTF) perceptions and their effects is not new, but this line of research has come to the forefront due to its importance to continuing debates on financial regulatory reform. While there is near-universal agreement that successful regulatory reform must address the risks and social costs posed by the problem of TBTF, there are wide differences of opinion about whether the legal and regulatory changes put in place since the crisis have in fact substantially addressed TBTF concerns.

A growing number of studies have attempted to identify TBTF effects in the form of lower funding costs and/or higher levels of risk-taking among firms that may be perceived by their creditors as too large, important, and complex to be allowed to fail. Collectively, such studies indicate that the strength of TBTF effects varies over time, and that policy changes can make a difference; the evidence for TBTF effects weakens after policy changes that are intended to increase the resiliency of the financial system and/or reduce the scope and likelihood of extraordinary government support for failing institutions.

Despite this, relatively little empirical research to date has focused on TBTF effects in the most recent years – precisely the period of most relevance to assessing whether the financial reforms put in place since 2010 are effectively addressing TBTF concerns. For example, two recent studies, "The End of Market Discipline? Investor Expectations of Implicit State Guarantees," by Viral Acharya, Deniz Anginer, and A Joseph Warburton (2013), and "Evidence from the Bond Market on Banks' 'Too-Big-to-Fail' Subsidy" by João Santos (2014), undertake an analysis of funding costs, and specifically of market spreads for bonds issued by US financial institutions. These studies offer empirical assessments of whether bond spreads are lower for large or systemically important institutions, and if this differential may be due to TBTF perceptions. However, neither study looks at bond spreads for 2012 and 2013. During this period, there have been substantial efforts by US financial policymakers to address TBTF concerns, including finalizing a range of enhanced prudential standards for the largest banking firms and providing more clarity about the process by which the FDIC could impose losses on the creditors of a large complex financial firm that failed without endangering the overall financial system.

This study therefore seeks to assess recent evidence on funding cost differentials among US Bank Holding Companies (BHCs), to better inform the debate about the future of financial reform in the US. Specifically, we measure differences in market spreads observed from 2009-2013 for senior unsecured bonds issued by US BHCs.

Our key findings are as follows:

- Using an analytical model very similar to that used in Acharya, Anginer, and Warburton (2013), we find that in 2009, bonds issued by US Global Systemically Important Banks (G-SIBs) traded at spreads more than 100 basis points less than bonds issued by other US BHCs. This result is consistent with the finding of Acharya, Anginer, and Warburton (2013) that large financial firms had significantly lower bond spreads during the financial crisis (after controlling for differences in bond characteristics and observable firm-level risks)

- Also consistent with Acharya, Anginer, and Warburton (2013), we find that this bond spread differential for G-SIBs declined in subsequent years
- Using more recent data, we extend the BHC bond spread analysis through 2013 and find that the sizeable G-SIBs funding differential of 2009 becomes insignificant by 2013
- We also find evidence, again consistent with the analytical results from Acharya, Anginer, and Warburton (2013), that these estimated funding spread differences incorporate effects other than TBTF perceptions, such as a general spread benefit associated with increasing firm size (a size benefit that is evident for BHCs in any size category)
- More generally, we describe and clarify the (strong) assumptions that are implicitly or explicitly made to support the interpretation of measured funding cost differences as specifically TBTF effects

Overall, our results are consistent with the hypothesis that post-crisis policy changes in the US meant to address TBTF concerns have had a gradual but economically significant impact, especially in the last one to two years.

1. Building on Existing Literature

The debate on the existence and impact of TBTF effects in the financial system continues to be enriched by a growing body of empirical research. The most promising approaches proposed to-date have measured the relationship between size (or other indicators of systemic importance) and

- Funding costs, such as for senior debt, subordinated debt, and deposits, to assess if larger institutions pay lower spreads and if these can be partially explained by lower credit risk sensitivity due to TBTF perceptions among creditors
- Default expectations, as signaled by market CDS spreads, to assess if these are lower (and undifferentiated) for institutions that may be perceived as TBTF
- Risk appetite, as signaled by the riskiness of assets, lending activities, or participation in generally higher-risk activities and markets in response to perceived TBTF support
- Market capitalization, including comparisons of stock returns and valuation of M&A “purchase premiums” paid to attain greater size and systemic importance commensurate with TBTF status[1]

A number of the studies that empirically assess TBTF effects on funding costs have analyzed bond spreads. These studies typically compare interest rates on bonds (relative to a Treasury security of comparable maturity) issued by presumed TBTF firms to bond spreads for other firms. After controlling for various issuer, issuance, and macroeconomic factors, differences in spreads between the two groups are generally interpreted as a measure of TBTF effects.

Among sources of information on bank funding costs, we view bond spreads as likely to offer the most robust empirical views of TBTF for several reasons:

- Senior and subordinated bonds, while small relative to BHC funding sources that are not very credit-risk sensitive (such as explicitly insured deposits and short-term funding secured by high quality collateral), are an economically important funding source for large US BHCs, generally contributing 5% or more of total liabilities for Global Systemically Important Banks (G-SIBs).
- Within the legal structure of BHCs, bonds are often issued by the top-level entity and are thus exposed to the full credit risk of the BHC. By contrast, deposits are bank-entity liabilities which benefit from the structural subordination (i.e. first-loss position) of holding company liabilities. This structural protection for bank liability holders dampens their overall risk-sensitivity, and is difficult to distinguish from potential TBTF effects.
- Data on bond market spreads are available for a reasonable number of issuers, so that there is a sufficiently large sample of risk-sensitive spread information to

[1] For a more detailed review of the literature, see Kroszner (2013) and Kumar and Lester (2014)

support analysis of potential TBTF effects. This is in contrast to CDS, which have little to no trading activity for US BHCs reference entities beyond the G-SIBs; repo rates, on which publicly-available data is limited (and which are collateralized); and deposit rates, which BHCs are directly involved in setting (and reporting at any granular level).

There are still many challenges to developing a reliable TBTF scorecard using bond spreads, including the primary challenge of using statistical models on limited and noisy data to differentiate highly correlated effects and interdependent relationships. Below, we discuss the approaches taken by prior prominent studies before describing our own approach to this challenging task.

In a recent working paper, Acharya, Anginer, and Warburton (2013) examine spreads on US-issued bonds of US financial institutions (including banks, insurers, broker-dealers, asset managers, trading exchanges, and insurance brokers) from 1990 to 2011. They argue that large institutions are supported by an implicit government guarantee based on evidence that (a) larger institutions have lower credit spreads relative to smaller institutions (implying lower credit risk), but (b) that there is no observable relationship between size and credit risk for institutions in their sample, using distance to default as the primary measure of credit risk. They further quantify the value of this implicit guarantee for the largest 10% of financial institutions by asset size through econometric analysis of bond spreads, estimating an average funding cost advantage of 24 basis points (bps) over the 21-year period, peaking at over 100 bps in 2009.

Santos (2014) concludes that the top 5 banks by asset size had a funding cost advantage of 41 bps on US-issued bonds relative to smaller peers over the 1985-2009 period. To test whether this advantage is related to general size effects, such as greater diversification of businesses and risks rather than to TBTF perceptions, Santos extends the analysis to non-banks and non-financial companies. He finds that the top 5 firms in each of these cohorts also enjoy funding cost advantages relative to smaller peers, and in the case of non-financial corporations, this differential is even larger (47 bps). However, upon replicating these analyses on the subset of AA- and A-rated bonds only, he finds that the large firm advantages are only statistically significant within the cohort of banks.

In two related analyses, Balasubramnian and Cyree (2012a and 2012b) examine spreads on senior and subordinated debt of US BHCs from 2009-2011. The authors find that spreads on senior debt for the 19 BHCs designated as Supervisory Capital Assessment Program participants changed from being 136-bps less than market-comparable spreads to 36 bps higher than market comparable spreads, after passage of the DFA. Further, after segmenting the firms between commercial banks and other types of institutions that converted to BHCs during the crisis, they conclude that the latter group also paid a post-DFA spread premium, although smaller than the premium paid by commercial bank firms. The authors also find that funding costs for subordinated debt increased dramatically for the 19 BHCs during this period, but that a discount of 61 bps persisted relative to smaller peers.

Araten and Turner (2013) conduct an analysis of funding spread differentials between US G-SIBs and other US BHCs over the period 2002-2011, across the range of major liability types. Controlling for firm-specific credit and macro-economic factors, they estimate that the weighted average cost of funds (across interest-bearing liabilities could plausibly show TBTF effects) associated with G-SIB status is 18 bps lower than for non-G-SIBs.

The recent IMF Global Financial Stability Report (2014) presents one of the few views of bond spread differentials that covers 2013. The report finds that bond spreads for US G-SIBs were over 200 bps lower than bond spreads for other BHCs in 2009; by 2013, the direction of the funding differential had reversed, with G-SIBs paying close to 75 bps more than non-G-SIBs. However, after restricting the set of non-G-SIBs to those that had a leverage ratio similar to that of the G-SIBs, the report finds that G-SIB spreads were roughly 100 bps lower in 2013. In contrast to the studies cited above, the bond spread analysis within the IMF report does not appear to control for a range of bond-specific characteristics that contribute to differences in spreads (including embedded optionality, coupon structures, and seniority), or for measures of firm risk other than leverage (which would likely miss, for example, differences in the riskiness of assets).[2]

The range of estimates for funding cost differentials put forward by these and other studies illustrates the impact of the design choices and empirical methods used. Specifically, the choice of time period, institutions included in sample (e.g., BHCs, all financial institutions, institutions with similar leverage ratios), institutions deemed to be potential beneficiaries of TBTF perceptions (e.g., top 5 by asset size, CCAR participants), funding instruments included in sample (e.g., subsets of bonds by credit rating or seniority), and controls for non-TBTF drivers of funding costs (e.g., credit ratings, distance to default) can add up to very different views on the scope and significance of TBTF effects. In the following section, we discuss the diversity of issuers and issuances in the bond markets, and describe our approach to making these key design decisions.

[2] In addition to assessing bond spread differentials, IMF (2014) measures TBTF effects using a contingent claims analysis (CCA) approach and a ratings-based approach. The former compares observed CDS spreads (which are expected to contain information on the likelihood of government support) with “fair value” CDS spreads (which are expected to disregard this information), interpreting the difference as the value of government support. The ratings-based approach compares institutions’ “stand-alone” credit ratings with “with support” ratings that incorporate ratings agencies’ views of expected government support. The ratings “uplift” is translated to a funding cost differential based on the historical average funding costs observed at each rating level. For a detailed discussion of approaches using CDS spreads and credit ratings, see Kroszner (2013) and Araten (2013).

2. Overview of the Market for BHC Bonds

The analysis of TBTF effects on funding costs are complicated by two related challenges. First, TBTF effects are best assessed using funding sources that are sensitive to the credit risk of the issuing institution; however relatively few funding sources truly reflect an institution's credit risk. In general, equity prices are expected to have weaker linkages to external support expectations than liabilities. Within the BHC liability stack, deposits are by far the most important source of funding, comprising 60% of G-SIB liabilities and 85% of liabilities for other BHCs. However, a large portion of US deposits is explicitly insured by the FDIC and therefore insulated from the credit risk of the BHC.[3] Secured funding including repurchase agreements and other collateralized debt, which by design limits credit risk, is another major funding source (over 15% for G-SIBs and nearly 5% for non-G-SIBs). Unsecured and uninsured liabilities, the best suited for analyses of TBTF effects, are an economically important but relatively small portion of the overall liability stack. In 2013, we estimate that unsecured bond funding comprised at least 5% and 3% of liabilities for G-SIBs and other BHCs, respectively.[4]

The second challenge is that a significant level of heterogeneity exists even within this relatively narrow liability class, and the disparate features of issuers and issuances within the bond market can complicate analyses of potential TBTF effects. Below, we discuss some of these features and describe considerations for constructing a comparable sample of bonds for analysis.

2.1. Selecting a Cohort of Issuers

Because TBTF effects result from market perceptions of the likelihood of implicit government support, it is likely to vary by jurisdiction, along with differences in financial regulation and policy, policymakers' commitments (and credibility) regarding institutional bail-outs, and the government's ability to finance bail-outs. While a study based on a population of global banks may offer insights about the global average level of TBTF subsidies, it will be insensitive to the heterogeneity of these effects across different jurisdictions and economies. Therefore, similar to the studies cited in the previous section, we focus our analysis on US issuers, and further, on issuers that are not ultimately owned by non-US parent organizations.

An additional consideration is the distinction between debt issued by the top-level BHC versus subsidiary companies. A creditor to the bank (whether a depositor, bondholder, or other liability holder) is explicitly and structurally more protected from loss than creditors to the bank's parent BHC. In principle, any TBTF effect should be

[3] For an analysis of funding cost differentials on uninsured deposit accounts, see Kumar and Lester (2014)

[4] The differences in credit risk exposure due to explicit insurance, use of collateral, and various other characteristics suggest that funding differentials, and potential TBTF effects, are likely to vary greatly across liability types. However, several recent studies, including IMF (2014), have applied funding differentials calculated on a single liability type, such as bonds, to the total dollar value of all BHC liabilities in order to estimate a value in dollars for TBTF subsidies. This approach clearly misestimates the dollar value of any such funding cost difference by ignoring important forms of credit protection that cover much of the liability stack.

most pronounced, and detectable, in the absence of other (explicit) credit protections. This suggests that BHC liabilities will generally be a more sensitive instrument than bank-level liabilities for testing hypotheses about relative funding costs and TBTF effects.

Within the cohort of US BHCs, institutions with different core businesses, i.e. banks, broker-dealers, specialty lenders, insurance underwriters, and asset managers, can have very different risk profiles (and different funding costs). To isolate the most comparable set of issuers, we further restrict the sample to institutions with major commercial or investment banking activities, excluding insurers and asset managers from the sample.[5] We also exclude any bonds originally issued by firms that were acquired prior to 2013.[6]

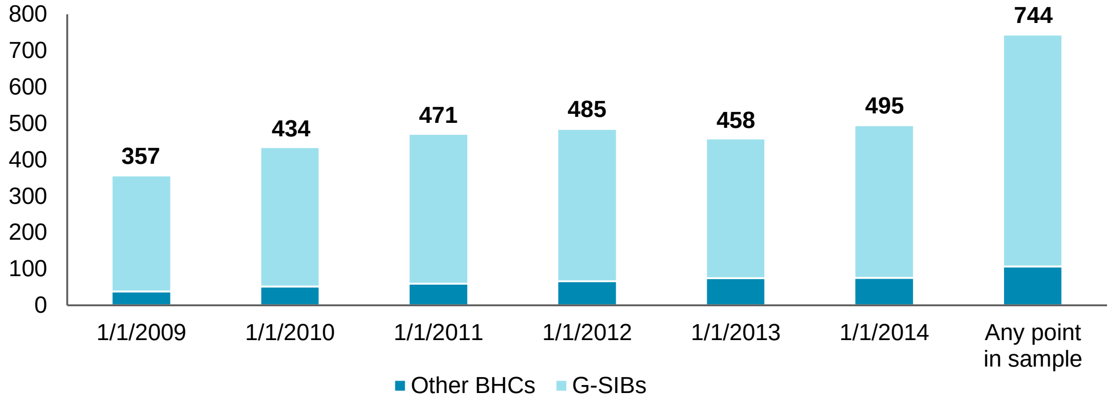
Using data from SNL Financial, we estimate that the aggregate value of bonds that were outstanding (at any point) during the period 2009 to 2013 for this set of US BHC issuers was $744 BN across 3,426 securities.

[5] Most notably, we exclude MetLife Inc., which had a very limited footprint in non-insurance businesses during the relevant period (and ultimately shed its BHC status in early 2013).

[6] In the majority of cases, we find that bonds issued by acquired firms trade at substantially different market spreads relative to bonds issued by their acquirers. Inclusion of these bonds in the econometric analysis will potentially bias our results by conferring the same balance sheet risk information on both acquiring and acquired firms, even though market-perceived risk is differentiated.

Figure 1: US BHC outstanding debt

Amounts outstanding ($ BN) on given date



Number of bonds outstanding

	1/1/2009	1/1/2010	1/1/2011	1/1/2012	1/1/2013	1/1/2014	Any point in sample
Other BHCs	127	175	206	211	227	229	374
G-SIBs	1,687	1,669	1,575	1,526	1,375	1,648	3,052
Total	1,814	1,844	1,781	1,737	1,602	1,877	3,426

Notes:
1. For top-level US BHCs with major commercial or investment banking businesses; excludes insurance underwriters and asset managers; excludes CIT Group and GMAC (renamed Ally Financial Inc.) due to limited data availability
2. Excludes structured products (bonds linked to the performance of an index or basket of securities) which had an outstanding value of $130 BN in 2013, since these are intended as solutions to bespoke client needs rather than as funding sources for financial institutions

Source: SNL Financial, Oliver Wyman analysis

We further segment our sample into BHCs that are considered systemically important, and therefore would be the most likely to benefit from any TBTF funding cost effects, and a comparison group of BHCs that can be assumed not to receive such a benefit. While no strong consensus has yet emerged on how to best delineate these groups, regulatory designations – and specifically the G-SIB designation – are straightforward and intuitively appealing. We observe that the vast majority of the policymaking, political, and public debate on TBTF and related issues have focused on the firms identified as G-SIBs. Indeed, the G-SIB designation is itself an explicit effort by global policymakers to identify firms that should be subject to policy measures intended to address TBTF effects and related concerns.[7]

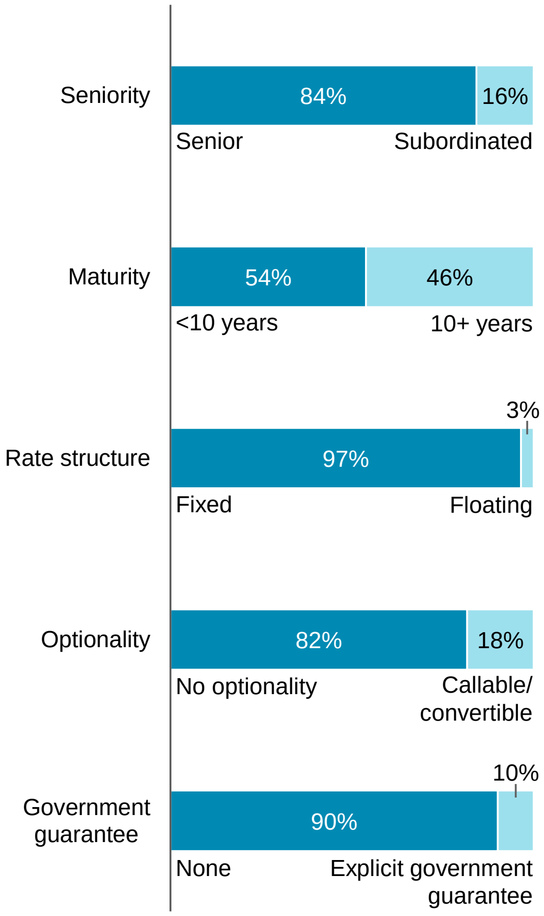
The figure above illustrates the overwhelming proportion of outstanding BHC debt that is issued by the 8 US G-SIBs, driven in part by these institutions' significantly larger balance sheets and in part by a stronger reliance on capital markets funding relative to deposits.

[7] The first such official list dates from November 2011, but the identity of the firms to be listed were widely anticipated during 2010 and 2011, as evidenced by numerous unofficial lists prepared during that period by market analysts and media outlets.

2.2. Identifying the Most Comparable Set of Bonds

Within the set of total outstanding BHC-issued debt, individual bonds are differentiated by their level of subordination in the capital structure, maturity, coupon structures, and various other characteristics that can have a material impact on spreads. Below, we illustrate the key features of US BHC-issued bonds.

Figure 2: Key features of BHC-issued bonds



The overwhelming majority of debt issued by BHCs is classified as senior debt, higher in the priority of claims than the smaller segment of subordinated claims. Senior debt typically has a lower yield relative to subordinated claims, commensurate with the lower credit risk assumed by bondholders.

About half of BHC-issued bonds have a maturity of 10 years or less (at issuance). In general, the shorter the term to maturity of a bond (the remaining life of the bond on any given date), the more predictable its future performance, and the lower the yield.

As the name suggests, floating rate bonds pay a variable coupon, usually based on an underlying reference rate such as LIBOR or Fed Funds. Relative to fixed rate bonds, these instruments expose bondholders to interest rate risk, and may trade at a premium or discount depending on the current and expected interest rate environment.

Bonds with embedded optionality, including convertible and callable bonds allow investors or issuers to take certain actions before the bond matures, e.g. to convert the bond into equity. The yield for these bonds incorporates the value of the option.

In 2009, the FDIC instituted the Temporary Liquidity Guarantee Program (TLGP), which lent an explicit government guarantee to certain unsecured credit obligations of financial institutions. Roughly 10% of bonds outstanding from 2009–2013 were issued under this program.

Note: Based on bonds outstanding at any point from 2009-2013
Source: SNL Financial, Oliver Wyman analysis

All of these features are likely to affect bond yields, and therefore the cost of funding for issuers. Thus, to construct the most comparable set of securities, we remove subordinated, floating-rate, callable, convertible, or government-guaranteed bonds from the set of bonds that were outstanding at some point from 2009-2013. The resulting sample consists of 1,212 bonds with a value of $440 BN issued by 42 BHCs.

3. Measuring TBTF Effects on Bond Spreads

For the bonds in our sample, we examine secondary market transactions between 2009 and 2013 for evidence of TBTF effects. We conduct two related analyses: first, we attempt to measure the funding cost differentials between bonds issued by G-SIBs and other BHCs that may be attributable to TBTF; second, we test whether these effects are unique to bonds issued by G-SIBs, or also present for BHCs that are large, but not generally identified as TBTF (i.e. BHCs with >$100 BN in assets). The following section describes our data sources, sample construction, and econometric analysis.

3.1. Data Sources and Preparation

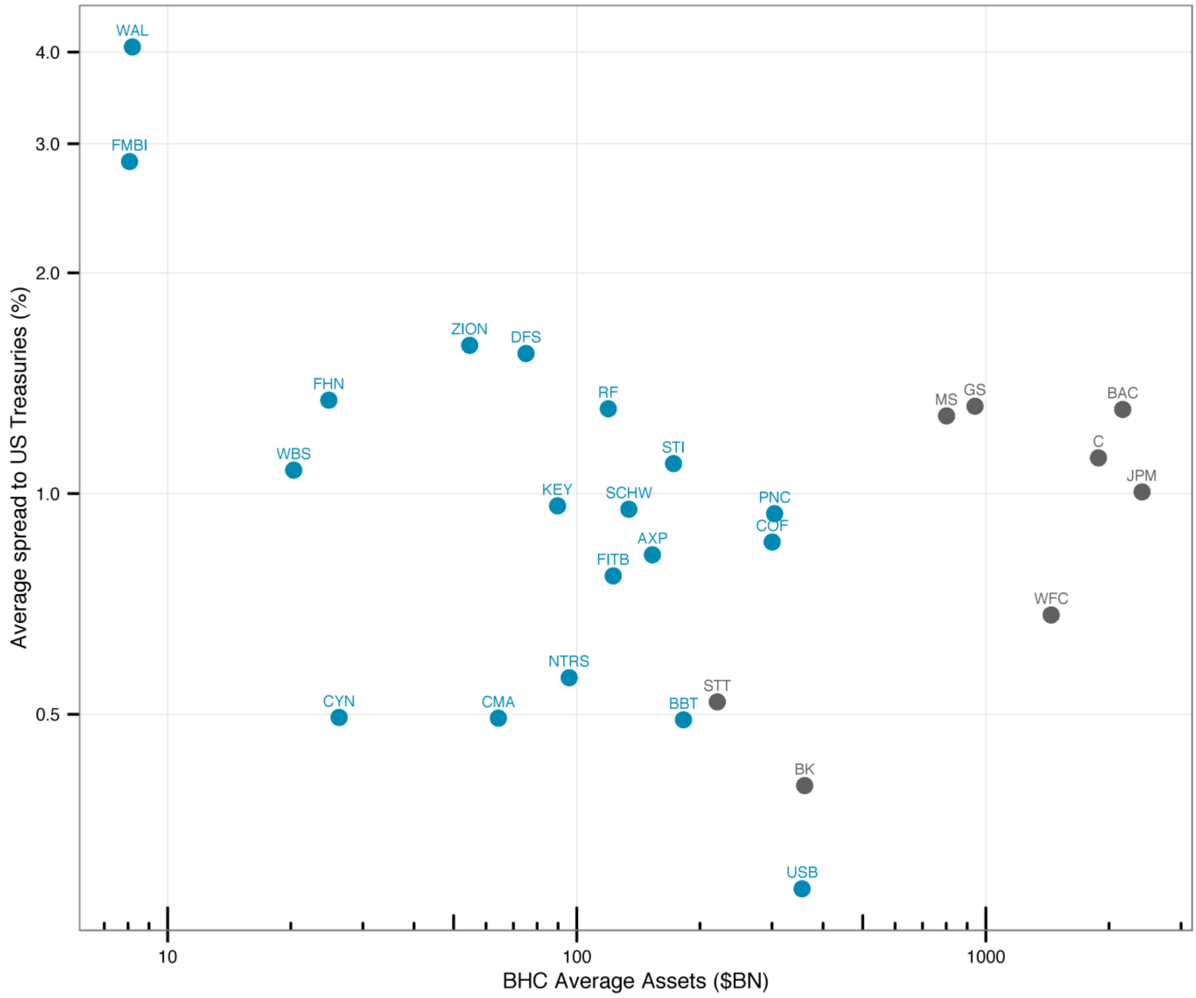
We source trade-level yield and volume data from FINRA's TRACE Enhanced Historical Data, which covers virtually every trade in US corporate bonds. The Enhanced Historical Data is released quarterly with an 18-month delay. We use available TRACE data for bonds of interest for all trading days from 2009 to June 2012. We combine the Enhanced Historical Data with a record of FINRA's publicly disseminated bond trade reports (compiled by MarketAxess) through February 2014. (We only examine trades executed through December 2013, but use reports of trade corrections and reversals for such trades through February 2014.) The publicly disseminated reports provide substantially similar information as the Enhanced Historical Data, except for the actual trade size for larger trades (which are simply flagged as greater than $5 MM in size). All trade records are cleaned for reporting errors consistent with the approaches described in Dick-Nielsen (2009) and Dick-Nielsen (2013).

We use SNL Financial to identify original issue dates, maturity dates, and other bond-specific information. We remove retail-sized trades (identified as trades of less than $100,000 in value), which account for the majority of all trades by count but only a small percentage of dollar volume. The resulting final trade-level sample includes 30 BHCs, 966 bonds with a total value of $425 BN, and approximately 1 MM trades.

For each trade, we calculate a spread to US Treasuries, defined as the difference between the FINRA-calculated market yield (based on the reported price for the trade) and a matched-maturity Treasury yield from the trade's execution date. Maturity-matched Treasury yields are interpolated from the Constant Maturity Treasury (CMT) yield curves published by the US Treasury. Given that the CMT is based on yields from highly liquid Treasuries, the calculated yields likely include risk premia not only for credit risk but also liquidity (and potentially other technical market influences).

Below, we show the 2013 trade-weighted average annual bond spread for each of the BHCs in our sample, organized by 2013 average assets. The figure suggests an inverse relationship between spreads and size for BHCs with up to $500 BN in assets (before controlling for differences in firm-level risks and other factors). However, this pattern of larger asset size being associated with lower spreads is actually stronger if one excludes the six largest BHCs, which do not appear to have any funding advantage on bond spreads relative to institutions with only $100 BN in assets.[8]

Figure 3: Average BHC-level bond spread, 2013



Source: TRACE, MarketAxess, SNL Financial, Oliver Wyman analysis

Looking at raw bond spreads in this way is informative, but the more important and more difficult question is how spreads vary with size, once we control (as best as possible) for observable differences in firm and bond characteristics.

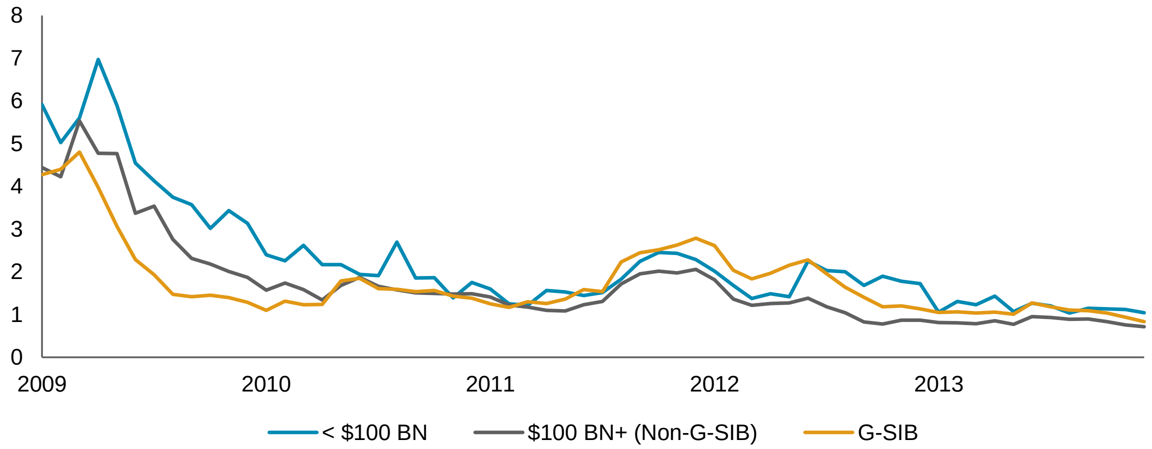
To do so using regression analysis, we construct a panel series consisting of the first trade in each bond in each calendar month. We then use a binary variable that indicates whether each BHC was listed as a G-SIB by the Financial Stability Board. While much of the TBTF research conducted to date compares this group (or its analog using different criteria) to all other firms in the sample, we believe a more

8 For 2013 (the year shown in Figure 3), the correlation between (log-log transformed) spread and asset size is -33%. For just firms with less than $500 BN in assets, the inverse correlation is -69%. For just firms with assets between $10 BN and $500 BN, the correlation is -40%.

robust comparison would be between firms that would likely benefit from any TBTF regime and other firms that, while large, are not generally considered so systemically significant as to present material TBTF issues. One of the goals of this analysis is to complement the work of prior studies by making that comparison directly and explicitly.

We therefore use a second indicator variable that marks a more inclusive subset of BHCs: those with >$100 BN in average assets between 2009 and 2013 (including the 8 G-SIBs). Our sample of 30 BHCs includes 16 such firms, including 8 BHCs that were not designated as G-SIBs. The median monthly spread among firms designated G-SIBs, non-G-SIBs with more than $100 BN in assets, and smaller BHCs are compared below.

Figure 4: Median spread to Treasury (%), by BHC cohort



Note: Median spread to Treasuries among the BHCs in each cohort; measured monthly usingweighted-average BHC bond spread for each month
Source: TRACE, SNL Financial, Oliver Wyman analysis

3.2. Econometric Analysis and Results

To assess whether post-crisis BHC bond spreads reflect the major legal and regulatory reform efforts intended to address TBTF concerns, we extend the analytical approach used in the 2013 working paper by Acharya, Anginer, and Warburton (hereafter referred to as AAW) that seeks to quantify the spread advantage of large financial firms on a yearly basis. The AAW quantification covers the period 1990–2011, and finds that the top 10% of financial firms (by asset size) had a spread advantage that peaked in 2009 at over 100 bps.

Like AAW, we use bond trade data to track the evolving differences in relative spreads among groups of issuers. One key difference between our analysis and that of AAW is that we use bond trade data covering 2009-2013, allowing us to assess more recent changes in relative bond spreads among different BHC issuers.

We follow AAW in constructing a panel consisting of one observation for each bond-month pair, and estimating a regression for each year. Our regression has the following structure:

$$Spread_{i,b,t} = \alpha + \beta_1 \times BidAsk_{i,b,t} + \beta_2 \times TermRemaining_{i,b,t} + \beta_3 \times \log(BondTradeCount)_{i,b} + \beta_4 \times LeverageRatio_{i,t} + \beta_5 \times ROAA_{it} + \beta_6 \times NetShorttermLiabilities_{it} + \beta_7 \times MktToBook_{it} + \beta_8 \times DistDefault_{it} + \beta_9 \times SpreadIndex_{i,b,t} + \beta_{10} \times GSIB_i + \epsilon_{i,b,t}$$

Subscript *i* denotes individual BHCs, *b* denotes individual bonds, and *t* denotes the trade date (for *Spread* and *SpreadIndex*, which are measured on a daily basis), or most recent monthly or quarterly figure as of the trade date (for firm-level variables). In common with AAW, we include remaining term to maturity as a bond-level control, plus measures of firm leverage, return on assets, market-to-book equity ratio, net short-term term funding, and Merton distance to default as firm-level controls. We also include a control for the bid-ask spread for dealer-to-customer trades, and a measure of bond-level liquidity.[9] AAW includes distinct variables to capture slope of the yield curve and the risk premia for corporate bonds; we use a single measure to control for the same factors, *SpreadIndex*, which is an average of all US corporate bond spreads with a similar remaining maturity as the BHC bond on the date of the trade. (More detailed descriptions of the variables used, including the methodology for calculating Merton distance to default, are included in the Appendix.)

The most significant difference between our analysis and the yearly quantification analysis of AAW is in the construction of the sample of included firms and bonds, and the corresponding dummy variable identifying “large” firms. The core quantification analysis of AAW includes a wide range of financial firms, most of which are not BHCs. It also includes more junior (subordinated) bonds (along with a corresponding dummy variable). By contrast, we restrict our sample to senior unsecured bonds issued by US BHCs. We also use as our (time-invariant) variable of interest whether or not each firm has been designated as a G-SIB. Because G-SIB status is a widely known firm-level designation intended to capture the very systemic importance that could lead to TBTF effects in bond spreads, we view it as a more logical variable of interest than alternative measures based simply on asset size.

For the years 2009-2011 covered by both our analysis and that in AAW, we find very similar results. AAW report that their estimated large-firm bond spread advantage peaked in 2009, at over 100 bps. It then declined to approximately 40 bps by 2011. Using our BHC-only sample, we estimate a similarly large and statistically significant bond spread advantage for G-SIBs in 2009, of 137 bps. Consistent with AAW, we find this estimated bond spread advantage associated with G-SIB status declining each year thereafter. By 2013, the measured G-SIB funding advantage has essentially disappeared (the coefficient suggests a small disadvantage for G-SIBs in 2013, though this effect is too small to be statistically distinguishable from zero.)

The following table summarizes the associated regression results.

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9 AAW includes similar liquidity metrics as robustness tests in separate regressions, but does not incorporate these into the reported quantification of bond spread advantages or subsidies.

Table 1: Regression results for yearly analysis of bond spread differences, G-SIBs vs. other US BHCs

	Dependent variable: Spread				
	Year				
	2009	**2010**	**2011**	**2012**	**2013**
Constant	1.655**	0.892	0.685	0.405	0.021
	(0.719)	(0.544)	(0.540)	(0.371)	(0.226)
BidAsk	0.282***	0.112***	0.119***	0.138***	0.090***
	(0.059)	(0.026)	(0.023)	(0.022)	(0.009)
TermRemaining	0.033**	0.015**	-0.030***	-0.017***	-0.0001
	(0.014)	(0.007)	(0.006)	(0.005)	(0.003)
log(BondTradeCount)	0.172**	-0.038	-0.068***	-0.054***	-0.065***
	(0.080)	(0.033)	(0.024)	(0.017)	(0.009)
LeverageRatio	0.008	0.051	0.045	0.156***	0.149***
	(0.036)	(0.041)	(0.052)	(0.039)	(0.025)
ROAA	-0.182***	-0.172***	-0.157***	0.020	-0.166***
	(0.049)	(0.047)	(0.042)	(0.086)	(0.027)
NetShorttermLiabilities	-0.008	-0.012**	0.004	0.003	0.003
	(0.006)	(0.006)	(0.005)	(0.005)	(0.002)
MktToBook	-1.347***	-0.434***	-0.383***	-0.310***	0.060*
	(0.137)	(0.118)	(0.132)	(0.108)	(0.034)
DistDefault	-0.041***	-0.034***	-0.037***	-0.058***	-0.015***
	(0.013)	(0.004)	(0.005)	(0.005)	(0.001)
SpreadIndex	0.544***	1.102***	1.747***	1.225***	0.695***
	(0.038)	(0.118)	(0.073)	(0.060)	(0.063)
G-SIB	-1.366***	-0.789***	-0.569***	-0.363***	0.080
	(0.201)	(0.177)	(0.216)	(0.125)	(0.062)
Observations	1,619	2,099	2,392	2,626	2,742
Adjusted R^2	0.486	0.348	0.607	0.582	0.592
Note:	*p<0.1; **p<0.05; ***p<0.01				

Standard errors have been for adjusted for heteroskedasticity (via HC3 weightings) and serial correlation using the approach found in Arellano (1987), clustered at the bond level.

Using an alternative panel data set, constructed using the same underlying trade-level data but aggregated up to the average firm-level spread observed each month, we find similar results, though the estimated G-SIB spread advantage drops more quickly, reaching just 4 bps by 2012.

3.3. Interpretation of Bond Spread Differences

Is the G-SIB bond spread advantage necessarily a TBTF subsidy? In short, no. As we noted above, simple visual examination of bond spreads for a range of BHCs suggests a correspondence between larger firm size and lower bond spreads among non-G-SIBs. This relationship is consistent with economic intuition and the finding that banks, at least up to some relatively high threshold, benefit from scale and scope advantages, including significant risk diversification.[10]

However, this basic relationship between larger firm size and lower bond spreads prevents the interpretation of any binary indicator of TBTF. If a strong relationship exists between size and bond spreads across all firm sizes, then any binary variable that divides firms into two size cohorts will show an effect, as it will capture the average spread differences between firms above the threshold and those below. Even if no firm benefited from a TBTF subsidy or any other funding advantage specific to the largest firms, a "large firm" indicator variable will reflect the general association between firm size and spreads. This is true of the top-10% asset-size indicator used as the primary "TBTF" indicator in the AAW study, of similar binary indicators in most TBTF studies, and of the G-SIB indicator variable we use above.

Various prior studies do much to try to disentangle funding benefits specific to the largest financial firms from general size effects. One approach, explored by AAW, Araten and Turner (2013), Kroszner (2013), and Santos (2014), among others, compares the large firm spread advantage between financial and non-financial firms. These studies find (to varying degrees) that large firms in other industries, in which TBTF perceptions are unlikely to play a role, also enjoy funding advantages relative to smaller peers. In general, however, the large firm spread advantage is relatively large for financial firms and banks. While this difference (between industries) in differences (between large and smaller firm spreads) is often interpreted as evidence for TBTF effects, this interpretation silently hinges on the expectation that the bond spread advantages for the largest firms should be equal across different industries. Given the wide variety in industrial organization and competitive structures across different industries, this assumption may be unwarranted.

A related approach uses a tiered set of size indicator variables that divide the sample of firms into more than two cohorts. As described in AAW, this approach provides an excellent example of the difficulty of interpreting large firm funding advantages as TBTF effects. When using multiple size cohorts, the AAW study finds that across their 21-year sample, the top 10% of financial firms had a (statistically significant) 23-basis-point bond spread advantage over smaller, but still relatively large firms (those in the 60-90th percentile of firms by size). Before interpreting this 23 basis points as a

[10] Several studies have found that larger banking institutions benefit from scale and scope advantages, including greater diversification across products, geographies, clients, and associated risks; fixed costs with increasing returns to scale; and larger networks of customers to adopt new products and services. For example, Hughes and Mester (2013) find evidence of economies of scale for banks with >$100 BN in assets, after controlling for TBTF-related funding advantages. Similarly, Wheelock and Wilson (2012) find that most US banks faced increasing returns to scale from 1984-2006.

TBTF effect, we notice that those smaller firms in the 60-90th percentile themselves benefitted from a 50-basis-point advantage over firms in the next cohort of still smaller firms (those in the 30-60th percentile by size), and that those firms in turn had spreads that were 37 basis points lower than the smallest 30% of firms. Without the strong assumption that the consistent non-TBTF-related association observed between increasing firm size and lower spreads suddenly disappears as we reach the top 10% of firms, it is impossible to disentangle the factors that might be contributing to the observed funding spread advantage for the largest firms: TBTF perceptions, general benefits associated with size that are observed in the smaller size cohorts, or a complex mixture of these and other influences.

Even if using multiple cohorts does not provide an empirically clear identification of TBTF effects, it does represent a step in the right direction, by beginning to distinguish different size-associated effects at different size cohorts. To provide this more nuanced view of the estimated G-SIB funding advantages in our own sample of BHC bonds, we apply the approach of using multiple cohorts to the yearly estimation of the G-SIB funding advantage that we discuss above. In addition to the G-SIB indicator variable, we include a second (non-mutually exclusive) indicator variable that identifies BHCs that have more than $100 BN in assets.

This specification allows us to measure the bond spread differentials between G-SIBs and other relatively large BHCs (those with at least $100 BN in average assets during the years covered in our study), controlling for at least part of the general size benefit (though not necessarily all of it). This improved measure of BHC spread differentials shows a general pattern consistent with our simpler analysis above: the G-SIB spread advantage (vs. just the relatively large non-G-SIBs that have more than $100 BN in average assets) is largest (over 100 bps) in 2009, and steadily declines thereafter. In fact, we estimate that G-SIBs had spreads that were 18 bps higher than large non-G-SIB BHCs in 2013.

Table 2: Regression results for yearly analysis of bond spread differences, for G-SIBs, $100 BN+ BHCs, and other US BHCs

	Dependent variable: Spread				
	Year				
	2009	2010	2011	2012	2013
Constant	2.312***	1.266**	1.109**	1.014*	0.689
	(0.707)	(0.546)	(0.538)	(0.528)	(0.706)
BidAsk	0.272***	0.107***	0.118***	0.135***	0.090***
	(0.058)	(0.026)	(0.023)	(0.022)	(0.010)
TermRemaining	0.035**	0.015**	-0.030***	-0.017***	0.001
	(0.014)	(0.007)	(0.007)	(0.005)	(0.004)
logBondTradeCount	0.201**	-0.030	-0.061***	-0.052***	-0.064***
	(0.081)	(0.034)	(0.023)	(0.016)	(0.008)
LeverageRatio	0.016	0.036	0.023	0.127***	0.101**
	(0.033)	(0.035)	(0.049)	(0.040)	(0.045)
ROAA	-0.189***	-0.161***	-0.133***	0.063	-0.123***
	(0.045)	(0.045)	(0.041)	(0.083)	(0.037)
NetShorttermLiabilities	-0.0002	-0.008	0.007	0.007	0.008
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
MktToBook	-1.367***	-0.413***	-0.374***	-0.290***	0.074*
	(0.148)	(0.118)	(0.137)	(0.108)	(0.038)
DistDefault	-0.039***	-0.034***	-0.037***	-0.059***	-0.014***
	(0.013)	(0.003)	(0.005)	(0.005)	(0.001)
SpreadIndex	0.524***	1.106***	1.757***	1.204***	0.679***
	(0.038)	(0.116)	(0.073)	(0.060)	(0.073)
Assets 100 BN+	-1.207***	-0.444	-0.417	-0.476	-0.393
	(0.373)	(0.369)	(0.336)	(0.329)	(0.354)
G-SIB	-1.037***	-0.694***	-0.475*	-0.241*	0.176***
	(0.200)	(0.189)	(0.260)	(0.145)	(0.067)
Observations	1,619	2,099	2,392	2,626	2,742
Adjusted R^2	0.498	0.354	0.610	0.587	0.603

Note: *p<0.1; **p<0.05; ***p<0.01

Standard errors have been for adjusted for heteroskedasticity (via HC3 weightings) and serial correlation using the approach found in Arellano (1987), clustered at the bond level.

4. Conclusions

We do not find strong evidence that differences in bond spreads between G-SIBs and other BHCs can be consistently attributed to TBTF perceptions over the 2009-2013 period. We use bond trade data to trace the evolving differences between G-SIB bond spreads and other BHC bond spreads. Our results are similar to that of AAW for the time periods in which our two studies overlap – we estimate a large and statistically significant bond spread advantage for G-SIBs of 137 bps in 2009 which declines each year thereafter, to 57 bps by 2011. Extending the analysis to 2013, we find that the measured G-SIB funding advantage continues to decline and becomes statistically insignificant (i.e. it cannot be confidently distinguished from zero).

Further, we find that even in the years that we do observe a G-SIB bond spread advantage, this advantage cannot necessarily be attributed to TBTF related factors. As in AAW, Santos (2014), and a host of other prior studies, we see a strong relationship between size and bond spreads across nearly all firm sizes; thus, any analysis that compares spreads between a set of “large” firms and smaller peers will find a funding cost advantage for the large firms, regardless of whether they are considered TBTF or have other size-related funding advantages.[11]

To provide a view of the estimated G-SIB funding advantage that may be attributable to TBTF effects versus general size effects, we include an indicator for firms with >$100 BN in assets in our model, alongside an indicator for G-SIB status. As expected, we find that firms with >$100 BN in assets also have funding cost advantages relative to smaller peers, and these advantages are consistent with the general pattern observed for G-SIBs from 2009-2013. The incremental effect picked up by the G-SIB indicator allows us to disentangle to some extent the funding cost differentials associated with being one of the 8 US G-SIBs from those that are associated simply with being a relatively large BHC. Under this more nuanced view, we find that G-SIBs had a spread advantage of 104 bps in 2009, which steadily declined to a funding cost disadvantage of 18 bps in 2013.

Our key finding – that the bond spread advantages of G-SIBs have declined significantly in the post-crisis period – is consistent with the premise that policy changes meant to combat TBTF have been effective. While any empirical finding of such a complex phenomenon as TBTF should be interpreted cautiously, we find the implication that post-crisis regulatory reforms have begun to have their most significant impact only in the last one to two years to be plausible. We would expect TBTF perceptions to change gradually, as investors absorb the wide-ranging and complex set of post-crisis regulatory reforms that have been put in place. With this in mind, financial policymakers should take the long view, and act with patience.

[11] These findings are consistent with those of our prior working paper, Kumar and Lester (2014), in which we observe a ‘general size effect’ on uninsured deposit funding costs. We find that banks with >$500 BN in assets have funding cost advantages over other banks in certain periods. However, banks with $100 BN - $500 BN in assets also have funding advantages over those with <$100 BN, and banks with $10 BN - $100 BN in assets have advantages over those with <$10BN.

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Appendix

Bank holding companies included in the econometric analysis, by cohort

Cohort	BHC	Ticker
G-SIB	Bank of America Corporation	BAC
	Bank of New York Mellon Corporation	BK
	Citigroup Inc.	C
	Goldman Sachs Group, Inc.	GS
	JP Morgan Chase & Co.	JPM
	Morgan Stanley	MS
	State Street Corporation	STT
	Wells Fargo & Company	WFC
>$100 BN assets (non-G-SIB)	American Express Company	AXP
	BB&T Corporation	BBT
	Capital One Financial Corporation	COF
	Fifth Third Bancorp	FITB
	PNC Financial Services Group, Inc.	PNC
	Regions Financial Corporation	RF
	SunTrust Banks, Inc.	STI
	U.S. Bancorp	USB
<$100 BN assets	Charles Schwab Corporation	SCHW
	City National Corp	CYN
	Comerica Incorporated	CMA
	Discover Financial Services	DFS
	First Horizon National Corporation	FHN
	First Midwest Bancorp Inc.	FMBI
	KeyCorp	KEY
	M&T Bank Corporation	MTB
	Northern Trust Corporation	NTRS
	Old National Bancorp	ONB
	Susquehanna Bancshares, Inc.	SUSQ
	Webster Financial Corporation	WBS
	Western Alliance Bancorp	WAL
	Zions Bancorporation	ZION

Note: Based on average assets across all quarterly figures that were publicly available over the period 2009-2013

Summary statistics for 2009–2013 bond-month panel (panel includes just first trade of any single bond each month)

Statistic	Description	Mean	25%	Median	75%	St. Dev.	N
Spread	Spread to matching Constant Maturity Treasury	1.984	1.086	1.716	2.508	1.362	15,404
BidAsk	1 for Dealer Buys from Customer trades, -1 for Dealer Sells to Customer trades, 0 for interdealer trades	0.075	-1	0	1	0.826	15,404
Term Remaining	Remaining number of years until bond's maturity date	6.366	2.364	4.275	7.740	6.602	15,404
BondTrade Count	Total count of all institutional trades for that bond, 2009–2013	2,651	147	1,491	4,320	2,969	15,404
DistDefault	Merton distance to default measure (see below for more detail)	14.440	1.491	10.600	24.660	17.390	11,609
NetShortterm Liabilities	Short term liabilities (net of cash), divided by assets	-9.372	-18.840	-8.730	-1.390	12.070	15,211
LeverageRatio	Reported regulatory leverage ratio; generally Tier 1 capital divided by average total consolidated tangible assets	7.699	7.000	7.310	8.080	1.331	15,195
ROAA	Prior quarter return on average assets	0.637	0.350	0.670	1.020	0.914	15,208
MktToBook	Quarter-end market value of equity divided by book value of equity	0.874	0.585	0.763	0.958	0.559	15,404
SpreadIndex	BAML US Corporate OAS sub-index matching the bond's remaining term, matched to date of trade	1.955	1.340	1.750	2.130	1.102	15,404

Note: Quarterly firm-level information for a given trade date is based on the last available quarterly set of balance sheet information, which we assume to be available as of the earnings announcement for that period

Methodology for Merton distance to default

Following Acharya, Anginer, and Warburton (2013), we include distance to default as a measure of the firm-level risk, calculated based on the credit risk model proposed by Merton (1974). The model treats the equity value of the firm as a call option on the firm's assets. Distance to default is the difference between the asset value of the firm and the face value of its debt, scaled by the standard deviation of the firm's asset value.

We calculate distance to default for each BHC on a monthly basis. In common with Acharya et al (2013), we solve the below simultaneous non-linear equations:

$$V_E = V_A e^{-dT} N(d_1) - X e^{-rT} N(d_2) + (1 - e^{-dT}) V_A$$

And

$$S_E = \frac{V_A e^{-dT} N(d_1) S_A}{V_E}$$

Where

$$d_1 = \frac{log\left(\frac{V_A}{X}\right) + \left(r - d + \frac{S_A^2}{2}\right)T}{S_A\sqrt{T}}; \; d_2 = d_1 - S_A\sqrt{T}$$

In these equations:

- *X* is total debt
- V_E is the market value of the institution
- S_E is equity volatility, calculated based on the standard deviation of weekly equity returns for the last 52 weeks
- *d* is the dividend rate, which we set to zero since we adjust equity market prices and firm market values to include any dividends paid over the period of our analysis
- *r* is the risk-free rate, which we set to the 1-year Constant Maturity Treasury rate
- *T* is time to maturity, which we set to 1 year

We solve the simultaneous equations above for the value of assets V_A and volatility of assets S_A. Then, Merton distance to default is computed as

$$Mertondd = \frac{log\left(\frac{V_A}{X}\right) + \left(m - d - \frac{S_A^2}{2}\right)T}{S_A\sqrt{T}}$$

Where *m* is the equity premium, which we assume to be 6%.[12]

[12] Acharya, Anginer, and Warburton (2013) calculate *m* as asset returns based on Campbell, Hilscher and Szilagyi (2008), and find that the results are similar under the simplified 6% equity premium assumption

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