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What Makes Large Bank Failures So Messy and What Should Be Done about It?

- The failures of large banks are not only costly—they destroy asset value and consume legal resources—but also destabilizing, in that they spill over to other financial institutions and cause more widespread instability.
- The messiness of these failures can be traced in part to large banks' reliance on uninsured financial liabilities (UFLs). UFLs include uninsured foreign and domestic deposits, repurchase agreements (repos), commercial paper, and trading derivative liabilities.
- To ease the problem of large banks' disorderly failures, regulators might require the banks to issue a certain amount of long-term "bail-in-able" debt, or "at-risk" debt that converts to equity in resolution.
- The stabilizing effects of an at-risk debt requirement cannot be achieved by simply requiring more equity; bail-in-able debt and equity are not perfect substitutes in providing financial stability if the resolution authority is slow to close the bank.

1. Introduction

This article uses "messy" repeatedly, so we should be clear at the outset what we mean by this term. Simply put, we mean that the failures of large banks are costly—in terms of destruction of asset value arising from fire sales—and also destabilizing—meaning their failure can threaten the operation of financial markets generally. We maintain that messy failures, so defined, are unique to large, complex, and interconnected banking firms. A small bank failure is costly, in terms of lost local output (Ashcraft 2005), but it does not threaten the smooth functioning of the financial system at large. Thus, small bank failures are costly, but not destabilizing. The failure of a large nonfinancial firm can also be costly, but it is not usually considered destabilizing; when the bankruptcy of General Motors Company was considered, most of the discussion was about lost jobs, not the stability of the automobile sector.

We contend that the reliance of large banks on *uninsured financial liabilities* is a key reason why their failures are so messy. We define uninsured financial liabilities (UFL) according to Sommer (2014) as liabilities that are issued specifically by financial firms, that is, uninsured foreign and domestic deposits, repurchase agreements (repos),

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commercial paper, and trading derivative liabilities.[1] These liabilities are special for two reasons. First, unlike a regular debt liability of a nonfinancial firm, uninsured financial liabilities confer money-like or liquidity services that may be impaired or destroyed in bankruptcy. This is one reason why the failure of financial firms is especially costly or messy. Another reason is that uninsured financial liabilities are *runnable*. Runs on the large firms relying heavily on UFL (or financial liabilities that are not fully collateralized) trigger fire sales that inflict losses not just on the firm in question, but also on other firms with similar portfolios of assets. That is what we mean by destabilizing—it is the threat of systemic consequences associated with the failure of a very large bank.

Our claim that the liabilities of financial firms are the defining feature that makes failures messy is not incompatible with the view that illiquid asset holdings or organizational/global complexity contributes to messy failures. While illiquid assets and organizational complexity are undoubtedly important, we suggest that large banks' liability structure is the defining feature that leads to messy failures. Simplifying a bit, uninsured financial liabilities are those liabilities that are runnable. When a financial firm experiences a run or fears a run in some part of its organization, it can trigger a fire sale of its assets as well as runs by holders of runnable liabilities in other parts of the firm or in other firms. So, in our view, the risk of a run is the element that catalyzes the fire sales and other rapid and destabilizing effects of a failure. The run creates a messy situation because as the holders of runnable liabilities run, they steal time from all other decisionmakers to respond in an orderly manner. When the firm fails, those holders of UFL that have not run lose twice, in the sense that they may ultimately receive a pro rata share of the asset values, which typically involves a loss, but they also will have lost the services they had counted on—for example, having a deposit that they would normally use to provide liquidity at a moment's notice to make purchases or investments.

We present some direct evidence in support of our hypothesis that uninsured financial liabilities contribute to messy failures. Using data on all failed banks and thrifts (herein "banks") resolved by the Federal Deposit Insurance Corporation (FDIC) from 1985 to 2011, we first show that banks more reliant on UFL in the year before their failure experience larger contractions in UFL in the ensuing year. This simple fact is consistent with the notion that UFL holders are prone to run. We then show that the estimated cost of failures to the FDIC is increasing in the amount of UFL on a bank's balance sheet in the year before failure. We take that as evidence for our premise that greater reliance on UFL leads to runs and fire sales of assets, which make failure costlier.

Having discussed what we think makes large bank failures so messy, we then turn to the question of what to do about it. Following Calello and Ervin (2010), European Commission (2012), Tarullo (2013), and others, we advocate that BHCs be required to issue a certain amount of long-term "bail-in-able" debt or, as we prefer, "at-risk" debt that converts to equity in resolution (we call it "at-risk" because the debt is at risk of being converted to equity). If issued in sufficient quantities, the at-risk debt requirement immunizes UFL holders from losses and thus reduces their incentive to run.[2] An at-risk debt requirement would also have helpful incentive effects as it would tend to discourage the over-issuance of UFL (although not so bluntly as an outright ceiling) that Stein (2012) highlights in the context of short-term debt.

One of the central contributions of this article is to counter the argument that the stabilizing effects of an at-risk debt requirement could be achieved by simply requiring more equity, thus obviating the need to impose a new requirement for this class of liabilities. According to that view, requiring x units of equity and x units of at-risk debt is no different, in stability terms, than requiring $2x$ in equity. To investigate the claim requires one to consider how the resolution authority behaves—that is, when it will shut down the firm. Using a simple model, we show that at-risk debt and equity are not strictly substitutes, assuming (plausibly, we think) that the resolution authority is slow to close a failing institution. The resolution authority in our model is "slow" in the sense that it will shut down and resolve a firm only once its (book) equity capital is exhausted. Granting that assumption, we show that holders of uninsured financial liabilities are less likely to run on a bank that has x in long-term debt and x in equity than a bank that has $2x$ in equity; resolution turns out to be more frequent under the at-risk debt requirement, but also more orderly. The at-risk debt functions as "capital in resolution" that serves to stall runs by holders of uninsured liabilities.

[1] Commercial paper issued by large bank holding companies (BHCs) is distinguished from nonfinancial company commercial paper in that the large BHCs tend to "make markets" in their own commercial paper, standing ready to buy it back under most circumstances. This feature makes commercial paper effectively demandable debt.

[2] We envision that the bail-in would happen in resolution under the FDIC's proposed single point of entry (SPOE) receivership. Under SPOE, the FDIC would take over the holding company and transfer its assets to a bridge financial holding company. The bridge bank would be capitalized by bailing in the subordinated and unsecured term debt held in the receivership. By taking over at the holding company level, the operating subsidiaries (for example, the bank) could continue with business as usual. Since the bridge bank would be well capitalized (and have adequate liquidity provided by the Orderly Liquidation Fund housed in the U.S. Treasury), uninsured liability holders should have little incentive to run.

Where we may differ from other proponents of an at-risk debt requirement is that we advocate scaling the requirement by the amount of uninsured financial liabilities held by the (consolidated) entity. The logic for this scaling is derived directly from our model of messy failures. First, the at-risk debt, scaled to the amount of UFL, will provide a buffer in resolution to protect holders of financial liabilities, forestalling runs by them. Forestalling those runs will reduce the messiness of the firm's failure. Consequently, designing the requirement to stop runs by the holders of UFL is as important to a successful requirement as is the buffering role of providing capital in resolution. Finally, by imposing such a requirement scaled to the amount of uninsured financial liabilities, and because issuing at-risk debt is expected to be costly to the firm, the requirement can provide the firms with incentives to reduce their reliance on UFL, which would improve the overall stability of funding by targeting the weak link in the large banks' funding models: uninsured financial liabilities. Stein (2012) argues that banks produce externalities when they issue short-term, money-like liabilities, which can consist of both insured liabilities and the uninsured financial liabilities that we are focused on. Tying an at-risk debt requirement to those liabilities would force firms to internalize those externalities to some extent.

In contrast with those who, in seeking to end the too-big-to-fail problem, suggest "breaking up the banks" or reimposing more stringent separation of commercial and investment banking as mandated in the Glass-Steagall Act of 1933, we offer a seemingly less radical but equally consequential change. We suggest that it is the liability side of today's large financial firms that should be restructured: The uninsured financial liabilities should be separated from the equity capital by an amount of long-term (at-risk) debt. To issue more UFL, the firm would be required in time to issue additional long-term (at-risk) debt. This structure of the liabilities of a large financial firm would assist in protecting the firm against runs, provide capital in resolution, and produce incentives for those firms to avoid excessive reliance on runnable liabilities. These benefits are not without costs, nor would they fully ensure against messy failures (topics we discuss later), but they would improve the chances that failures would be avoided in the first place and, if encountered, be of a more manageable scale.

The next section makes some preliminary points about the problem of "messy" bank failures. Section 3 presents evidence that UFL holders at failing banks are prone to run and that those runs add to the cost of resolving those failures. Section 4 advocates and provides analytics in support of a long-term (at-risk) debt requirement as a way to deal with the problem of messy bank failures. Section 5 provides a general discussion of our results. Section 6 summarizes our findings.

2. Preliminaries

Why are bank failures more disruptive than those of nonfinancial firms? As Sommer (2014) explains, bank failures are different because banks issue money as liabilities.[3] One can think of "money production" as one of the most important services provided by banks. While textbooks often define banks as intermediaries that gather the savings of households and lend to productive enterprises, most economic models of banks emphasize the point that banks issue deposits, or other money-like liabilities (Diamond and Dybvig 1983 and Gorton and Pennacchi 1990), and that the demandable deposits issued by banks are the source of messy failures of banks when the depositors run.

More recently, banks have expanded their organizational forms and activities (see Avraham, Selvaggi, and Vickery [2012]). As reviewed by Gorton and Metrick (2010), the rise of "shadow banking" has led to innovative forms of liabilities, such as repos, that are the functional equivalent of what used to be provided only by deposits.[4] Gorton and Metrick (2010) argue that repos are therefore a type of money because they are liquid, functionally demandable at par due to their largely overnight tenor, and able to function as an overnight store of value. Similarly, other forms of uninsured financial liabilities, such as commercial paper issued by banks, are also demandable at par for large customers that request the financial firm to "buy back" its paper. As a result, a large amount of big financial firms' funding is made up of uninsured financial liabilities, which provide the monetary services of demandability at par and apparent safety. They are consequently runnable.

It is important to note that U.S. and much international law recognizes the unique characteristics of some uninsured financial liabilities and specifically excludes them from the stay that bankruptcy imposes on creditors. For many repo contracts, and for most derivative contracts, the creditors can exercise their right of close-out and sell collateral immediately. This carve-out specifically recognizes that those claims

[3] Versions of this point have been made before. Friedman and Schwartz (1963) famously argued that the Great Depression was aggravated by bank failures that contracted the supply of bank liabilities—that is, money. Corrigan (1982) made a similar point, although more narrowly, in his famous paper "Are Banks Special?"

[4] To be sure, repo finance has been around for decades, but its use has grown exponentially.

on the firm are "special" and that the law in many cases allows holders of those claims to exit their claim (by selling collateral) rather than having to petition the bankruptcy court for it. In addition, the special resolution regime for banks and deposit insurance also recognizes the social value of preserving the main financial liabilities of a bank—its deposits—even in the event of the bank's failure.

Most bank deposits in the United States are insured by the FDIC.[5] Because insured depositors are relatively unaffected by the failure, a bank has the capacity to issue additional deposits even if it is economically insolvent, in the sense that the market value of its liabilities exceeds that of its assets. Consequently, a bank is typically put into resolution by its supervisor. In the United States, the FDIC resolves failed U.S. banks. For most of these failed banks, the capital structure is relatively simple, consisting primarily of insured deposits along with equity, but often with an additional portion of deposits that are uninsured. The firm is resolved in one of several ways, often by transferring deposits and an equivalent amount of assets to another bank in such a way that depositors maintain full access to their deposit accounts without interruption.

Our thesis is that bank failures are messy because holders of uninsured financial liabilities can and do run to avoid the consequences of failure. Financial liabilities are often redeemable on demand at par, or subject to frequent rollover. As financial liability holders run, the bank must borrow to replace the funding it loses to the run, or sell assets quickly. The asset sales can lead to deeply discounted prices (that is, fire sales), (further) imperiling the solvency of the bank and imposing costs on unaffiliated parties. In addition, because other financial institutions demand uninsured financial liabilities from banks because of their money-like properties, the failure of the issuing bank can bankrupt the institutions holding their liabilities (apart from fire sales). The leading example, of course, is the money market fund Reserve Primary Fund; after Lehman Brothers filed for bankruptcy, that fund "broke the buck" after Lehman Brothers filed for bankruptcy because it was holding $535 million of Lehman's commercial paper.[6]

To be clear, we are not saying that reliance on UFL is the only feature that makes bank failures costly. We know from Ashcraft (2005) that even small bank failures are costly in terms of forgone output. His findings could reflect that bank failures destroy the private information that banks develop about their borrowers so that erstwhile borrowers become credit constrained after the failure. Our position is that larger banks' reliance on uninsured financial liabilities is what makes their failures *messy*—that is, both costly and destabilizing to other banks and the financial system. In other words, small bank failures are "merely" costly, but large, UFL-dependent bank failures are messy.

3. Testing Our Thesis

Recall our thesis that uninsured financial liabilities contribute to messy (costly and destabilizing) large bank failures for two reasons. First, the money-like services provided by those liabilities are destroyed in the event of failure. Second, UFL are runnable, which can lead to fire sales of assets that not only destroy value at the failing institution, but can also have spillover costs on other institutions with similar asset holdings. This section provides some evidence on both points. First we show that UFL holders at failed banks are prone to run. Then we provide evidence that greater reliance on such liabilities leads to messier—that is, costlier—failures.[7]

Chart 1 plots the various components of UFL—uninsured domestic deposits, foreign deposits, repos, commercial paper, and derivative liabilities—by BHC asset decile. In general, UFL increases with BHC size, primarily because of increasing reliance on uninsured deposits. For BHCs in the 90th percentile, the class comprising megabanks, there is a sharp increase in the share of liabilities accounted for by UFL. The jump reflects increased reliance on virtually every component of UFL except uninsured domestic deposits. This chart neatly makes the point that if, as we maintain, reliance on UFL makes for messy bank failures, then we would expect large bank failures to be especially messy.

To test the hypothesis that UFL holders are prone to run when a bank is in distress, we turned to the FDIC database on failed banks. The data include 1,619 instances of failed banks or thrifts ("banks") between 1985 and 2011. Summary statistics for the banks, including those for a number of variables we use in a subsequent regression, are reported in Table 1. The statistics are measured at the quarter of failure, unless otherwise indicated. The average assets of the failed banks over this period (at the quarter of failure) totaled only about $275 million, so these are not the large banks that most interest us. Nevertheless, the data represent a useful laboratory to test our ideas.

[5] According to Federal Financial Institutions Examination Council, *Consolidated Reports of Condition and Income*, insured deposits made up 61 percent of all domestic deposits in the fourth quarter of 2012.

[6] The Reserve Primary Fund was also holding $250 million of medium-term notes. See http://www.reuters.com/article/2010/04/14/reservefund-lehman-idUSN1416157520100414.

[7] Since we are studying smaller bank failures here, we do not test for evidence that UFL is associated with more financial instability.

To test the run hypothesis, we estimated the following regression:

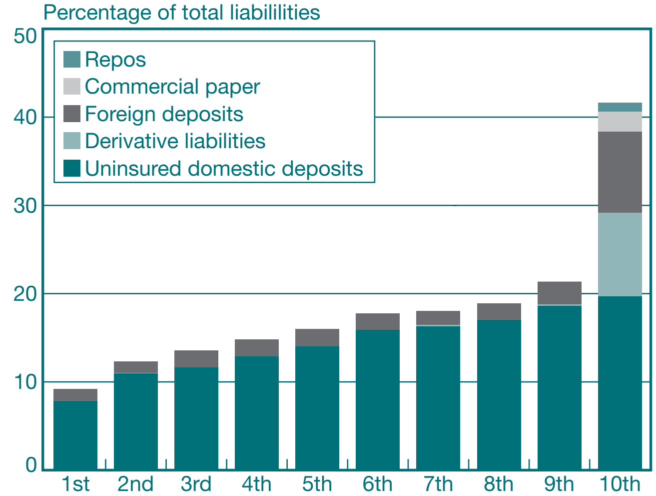
$$\frac{UFL_{it} - UFL_{it-4}}{Assets_{it-4}} = a + \frac{\beta UFL_{it-4}}{Assets_{it-4}} + \lambda \log(Assets_{it-4}) + \varepsilon_{it-4}.$$

Our hypothesis is that $\beta < 0$, that is, failing banks or thrifts experience larger runoffs of UFL over the year before their failure, the larger their UFL holding the year before failure. Despite the *t* subscript, this is not a panel regression; we are simply regressing the scaled, four-quarter change in *UFL* on the *UFL* four quarters earlier for the set of 1,619 failed banks and thrifts. The regressions include fixed effects for the state in which the failure occurred and the type of insurance fund.[8]

[8] Before 1989, there were two federal deposit insurance funds, one administered by the FDIC, which insured deposits in commercial banks and state-chartered savings banks, and another administered by the Federal Savings and Loan Insurance Corporation (FSLIC), which insured deposits in savings associations with state or federal charters. In 1989, the Financial Institutions Reform, Recovery, and Enforcement Act (FIRREA) specified that thereafter the FDIC would be the federal deposit insurer of all banks and savings associations and would administer both the FDIC fund, which was renamed the Bank Insurance Fund (BIF), and the replacement for the insolvent FSLIC fund, renamed the Savings Association Insurance Fund (SAIF). Although it was created in 1989, the SAIF was not responsible for savings association failures until 1996. From 1989 through 1995, savings association failures were the responsibility of the Resolution Trust Corporation (RTC). In February 2006, the Federal Deposit Insurance Reform Act of 2005 provided for the merger of the BIF and the SAIF into a single Deposit Insurance Fund (DIF). Necessary technical and conforming changes to the law were made under the Federal Deposit Insurance Reform Conforming Amendments Act of 2005. The merger of the funds was effective on March 31, 2006.

Chart 1

Uninsured Financial Liabilities, Sorted by Asset Decile



Sources: Board of Governors of the Federal Reserve System, *Consolidated Financial Statements of Bank Holding Companies* (FR Y-9C data); Federal Financial Institutions Examination Council, *Consolidated Reports of Condition and Income*.

Note: The chart plots the UFL components of U.S. bank holding companies (BHCs) as a percentage of total liabilities at different asset sizes. To construct this chart, we split the set of BHCs in 2012:Q4 into deciles, according to total asset size. We proxy BHC-level uninsured domestic deposits for a particular asset decile with bank-level uninsured domestic deposits for the same decile. All other line items are obtained from the Federal Reserve's Y-9C Form.

Table 1

Summary Statistics Calculated for Failed Banks and Thrifts from 1985 to 2011

Variables	Observation	Mean	Median	Standard Deviation	Minimum	Maximum
Log [estimated loss to FDIC]	1,619	9.15	9.11	2.06	0.00	15.35
Uninsured financial liabilities (thousands of dollars) — lag 4Q	1,619	71,467.16	3,877.00	41,3971.59	0.00	8,233,800.00
Uninsured financial liabilities / assets — lag 4Q	1,619	0.11	0.08	0.11	0.00	0.84
Log [uninsured financial liabilities / assets] — lag 4Q	1,619	0.10	0.07	0.10	0.00	0.61
GDP growth	1,619	0.62	0.64	0.64	-2.30	1.95
Log [assets]	1,619	10.98	10.73	1.53	7.46	17.05
Assets (thousands of dollars)	1,619	274,726.91	45,573.00	1,141,216.61	1,731.00	25,455,112.00
Commercial real estate loans / assets	1,619	0.21	0.15	0.18	0.00	0.78
Real estate owned / assets	1,619	0.05	0.04	0.05	0.00	0.53
Loans past ninety days / assets	1,619	0.02	0.01	0.03	0.00	0.28
Total equity capital / assets	1,619	-0.01	0.00	0.06	-0.48	0.52
Asset growth	1,619	-12.35	-14.84	21.80	-63.43	359.58

Source: Federal Deposit Insurance Corporation.

Notes: All balance sheet variables are measured at the date of failure. Asset growth (yearly rate) is measured at the quarter of failure.

Table 2

Is Higher UFL Associated with More UFL Runoff at Failed Banks?

	Failed Banks		Healthy Banks	
	(1)	(2)	(3)	(4)
UFL / assets — lag 4Q	-0.502***	-0.507***	-0.268***	-0.287***
	[0.037]	[0.059]	[0.061]	[0.092]
Log assets — lag 4Q	0.002	0.008***	0.007**	0.006
	[0.002]	[0.003]	[0.003]	[0.006]
Constant	-0.005	-0.073***	-0.045	-0.037
	[0.018]	[0.025]	[0.029]	[0.046]
Observations	1,619	1,619	1,619	1,619
Adjusted R-squared	0.334	0.361	0.084	0.083
Fund FE		YES	NA	
State FE		YES	NO	YES

Source: Authors' calculations.

Notes: The table reports ordinary least squares (OLS) regression and robust standard errors (clustered by time and state) in parentheses. The dependent variable is the change in UFL over the previous year, scaled by assets four quarters before failure. For a placebo test, we tested whether the relationship between lagged UFL and the change in UFL holds for a matched sampled of healthy banks. Healthy banks were matched by state, entity type, assets (within 25 percent of matching failed banks), and date. Robust standard errors are presented in brackets.

*** $p < 0.01$
** $p < 0.05$
* $p < 0.1$

The results are reported in Table 2, models 1 and 2. Consistent with the hypothesis, we observe $\beta < 0$, with the estimate significant at the 1 percent level. The point estimate in model 2 (with all the fixed effects) implies that a failing bank or thrift with the mean ratio of $UFL_{t-4}/Assets_{t-4}$ (11 percent) experiences a runoff of 5.5 percent of assets. We can express the run in dollar terms if we assume that the bank with mean $UFL_{t-4}/Assets_{t-4}$ also has mean assets ($275 million). In that case, the bank would experience a run of 0.055 × $275 = $15 million. Note from the summary statistics (Table 1) that failing banks did experience substantial asset contractions in the year before their failure.[9]

To see if our run regressions were simply picking up regression toward the mean, we also estimated placebo regressions for a set of matched nonfailing (healthy) banks. The healthy banks were matched by state, entity type (bank or thrift), asset size, and date.[10] In fact, we do observe a significant relationship between the lagged level of UFL and the change in UFL, suggesting that some regression toward the mean may explain some of the link between lagged UFL and UFL runoff observed for models 1 and 2. Note, however, that the coefficient on lagged UFL in models 1 and 2 is substantially larger for failed banks—almost twice as large, in fact. Using a Chow test, we can reject at below the 1 percent level that the coefficient on lagged UFL for failed banks in model 1 equals the corresponding coefficient for healthy banks in model 3.[11] We take the extra sensitivity of the change in UFL to lagged UFL for failed banks as evidence that failing banks do experience runs by holders of UFL.

The greater tendency for UFL to run off from failed banks is apparent in the histograms plotted in Chart 2 and Chart 3. The histogram for the failed banks is skewed negative while the histogram for the healthy, matched banks is more symmetrically distributed around zero. The skewness statistic for failed banks is -0.939. The statistic for healthy banks is -0.004.

Now we present some regression evidence consistent with the hypothesis that higher UFL is associated with costlier

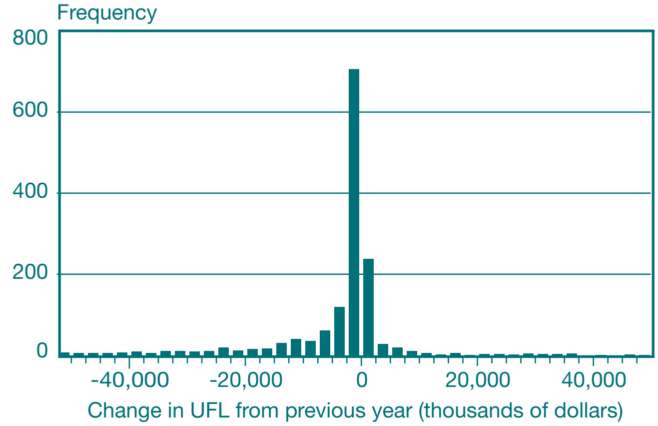
[9] Our premise is that a run on UFL triggered a contraction. However, we cannot rule out the opposite causality—that is, that assets were contracting so the UFL was allowed to run off.

[10] The healthy banks were considered a match by assets if their assets were within 25 percent of the failed bank.

[11] We cannot do a Chow test for models 2 and 4 because the fixed effects differ.

Chart 2

Failed Banks

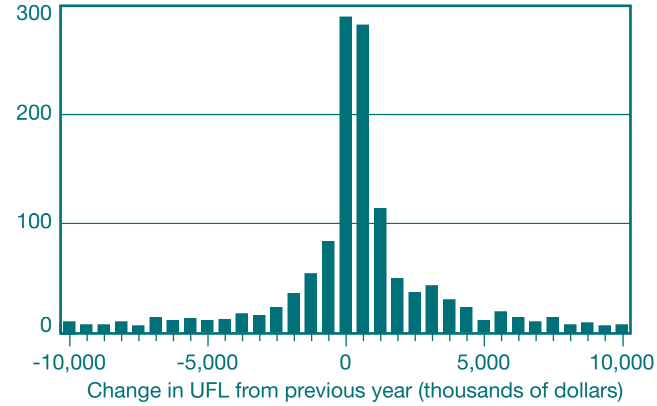


Source: Board of Governors of the Federal Reserve System, *Consolidated Financial Statements of Bank Holding Companies* (FR Y-9C data); Federal Financial Institutions Examination Council, *Consolidated Reports of Condition and Income*.

Note: The chart plots the UFL components of U.S. bank holding companies (BHCs) as a percentage of total liabilities at different asset sizes. To construct this chart, we split the set of BHCs in 2012:Q4 into deciles, according to total asset size. We proxy BHC-level uninsured domestic deposits for a particular asset decile with bank-level uninsured domestic deposits for the same decile. All other line items are obtained from the FR Y-9C.

Chart 3

Healthy Banks



Source: Board of Governors of the Federal Reserve System, *Consolidated Financial Statements of Bank Holding Companies* (FR Y-9C data); Federal Financial Institutions Examination Council, *Consolidated Reports of Condition and Income*.

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failures. As before, we use the FDIC's data on bank failures, except now we focus on estimated losses (to the FDIC) associated with bank and thrift failures; the estimated loss is the difference between the amount disbursed from the insurance fund and the amount estimated to be ultimately recovered from liquidation of the receivership estate.[12] According to our hypothesis, failing banks with more UFL in the period leading up to their failure are more likely to have to "fire sale" assets, and the attendant liquidation costs should be expected to increase the costs of the failure to the deposit insurer.

Our regression model is

$$\log\left(\frac{\text{Losses}_{it}}{\text{Assets}_{it}}\right) = \alpha + \beta\log\left(\frac{UFL_{it-4}}{Assets_{it-4}}\right) + \lambda' Controls_{it} + \varepsilon_{it}.$$

On the right-hand side, we lag UFL by four quarters for consistency with the run regression results.[13] For controls we use the same set of variables shown by Schaeck (2008) to influence FDIC losses on failures. We also include fixed effects for the state where the failure occurred, the transaction type (failure or assistance), and the type of insurance fund. We report ordinary least squares (OLS) estimates and Tobit estimates (since the dependent variable is truncated at zero). We predict $\beta > 0$.

Columns 1 and 2 of Table 3 reveal a positive and significant (at the 5 percent level) relationship between the costs of failure and the level of UFL four quarters earlier, that is, the failures of banks with more UFL are costlier. Given that the distribution of UFL is so heavily skewed toward larger institutions, we tried splitting the sample and estimating the model separately for failed institutions with assets below the median for the sample ($45.6 million) and institutions with assets above the median. Splitting the sample reveals an interesting difference: The positive relationship between the cost of failure and the amount of UFL holds only for the larger failed banks in the sample; for the smaller banks, there is also a positive relationship, but it is not significant. The OLS coefficient estimate in model 3 implies that a 10 percent (roughly one standard deviation) increase in the ratio of

[12] See the FDIC's data on failed banks at http://www2.fdic.gov/hsob/SelectRpt.asp?EntryTyp=30.

[13] Assets on the left-hand side are measured at the quarter of failure.

Table 3
Is Higher UFL Associated with Costlier Banks?

	All Banks		Assets > Median		Assets < Median	
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	TOBIT	OLS	TOBIT	OLS	TOBIT
Log UFL / assets – lag 4Q	1.010**	1.005**	1.449***	1.455***	0.663	0.650
	[0.429]	[0.428]	[0.491]	[0.481]	[0.834]	[0.817]
GDP growth	-0.118**	-0.119**	-0.065	-0.065	-0.114	-0.116
	[0.050]	[0.050]	[0.060]	[0.059]	[0.082]	[0.081]
Log assets	0.755***	0.755***	0.748***	0.747***	0.990***	0.992***
	[0.056]	[0.056]	[0.085]	[0.083]	[0.084]	[0.083]
Commercial real estate loans / assets	0.949***	0.955***	1.516***	1.533***	0.214	0.216
	[0.328]	[0.327]	[0.440]	[0.433]	[0.410]	[0.401]
Real estate owned / assets	4.929***	4.952***	6.710***	6.768***	3.089***	3.097***
	[0.587]	[0.585]	[1.104]	[1.088]	[0.646]	[0.632]
Loans past ninety days / assets	6.256***	6.291***	7.297***	7.352***	4.846***	4.858***
	[1.018]	[1.008]	[2.066]	[2.003]	[0.832]	[0.812]
Total equity capital / assets	3.386***	3.398***	-4.816***	-4.831***	-2.221***	2.231***
	[0.659]	[0.652]	[1.352]	[1.322]	[0.692]	[0.673]
Asset growth	0.004**	0.004**	0.006**	0.006**	0.002	0.002
	[0.002]	[0.002]	[0.003]	[0.003]	[0.002]	[0.002]
Constant	-0.009	-0.021	-0.673	-0.684	-2.052**	-2.078**
	[0.543]	[0.540]	[0.942]	[0.917]	[0.846]	[0.833]
Observations	1,619	1,619	809	809	810	810
Adjusted R-squared	0.611		0.512		0.379	
Fund FE	YES	YES	YES	YES	YES	YES
State FE	YES	YES	YES	YES	YES	YES

Source: Authors' calculations.

Notes: The table reports regression estimates and robust standard errors (in parentheses). The dependent variable is the estimated cost of failure to the FDIC per assets. Coefficients are estimated over the indicated number of failures over the period 1985 to 2011.

UFL to assets is associated with a 15 percent increase in the ratio of estimated costs to assets. This should be viewed as a lower bound of the costs associated with UFL because our dependent variable does not capture the effect of fire sales on the solvency of other banks. Note also that the cost of failure is significantly increasing in the log of assets; failures of larger banks are messier.

4. What to Do about the Problem of Messy Failures?

Having argued and provided some evidence that reliance on uninsured financial liabilities is one reason why large bank failures are so messy, we now turn to the question of what to do about it. We cannot simply argue that banks should eschew the use of such liabilities because the liquidity they create is socially valuable. Instead, we join the chorus of those calling for a long-term debt requirement, where the debt is bail-in-able—that is, it converts to equity in resolution.

Given that the debt is at risk of being converted to equity, we prefer the term at-risk debt. We have three points to make regarding the potential benefits of an at-risk (or subordinated) debt requirement based on the amount of a bank holding company's financial liabilities.

The first point, which we spend some time on, is to counter what is perhaps the most important possible objection to an at-risk debt requirement. Stated simply, the objection is that equity and at-risk debt are substitutes in terms of providing financial stability. For example, suppose that the BHC has $1 trillion in risk-weighted assets and a $75 billion Tier 1 common equity requirement; furthermore, consider an at-risk debt requirement of an additional $75 billion. Then one might object, why not make the Tier 1 common equity requirement equal to $150 billion? In that case, the bank's UFL will be roughly equally protected against shocks to asset values, and the BHC will not be put into resolution as frequently.[14] Therefore, the at-risk debt requirement is superfluous relative to an equity requirement that is higher by the exact amount of the at-risk debt requirement.

Treating equity and at-risk debt as equally costly (that is, not granting any benefits to the tax deductibility of interest expense on debt), one still has to consider three issues before concluding that the protection achieved by an at-risk debt requirement can be duplicated by a larger equity requirement. One has to specify 1) the rule by which the resolution authority puts the BHC into resolution, 2) the process by which losses accrue, and 3) the incentives of the bank to issue uninsured financial liabilities.

First, because long-term debt and equity are generally more expensive forms of funding for a financial firm, we assume that, without the requirement to issue at-risk debt, the BHC would issue UFL to the extent feasible, up to its required equity.[15] Second, we assume—and this is critical—that the resolution authority puts the BHC into resolution only after it has experienced losses in excess of its equity.[16] Finally, we assume that the loss-generating process is a relatively "smooth" one, so that there are no large jumps to default; instead, the BHC transits through relatively small losses to larger losses (this process could be a random walk, but the size of incremental losses, if not continuous, is small; alternatively, and more realistically, it could be a process with significant serial correlation). With these three assumptions, we now demonstrate that a larger equity requirement is not equivalent to an equity requirement plus an at-risk debt requirement.

Consider a BHC with a large equity requirement ($150 billion in our example) versus one with both equity and at-risk debt requirements (a $75 billion equity requirement and a $75 billion at-risk debt requirement). We assume, for this exercise, that both BHCs have issued the same amount of UFL and they both have the same asset composition. Now, when the firm has the high equity requirement, all of its remaining liabilities are in the form of UFL. As the firm experiences losses that grow from 13 to 14 to 15 percent of its risk-weighted assets, the holders of the UFL realize that they have no further "buffer" that would limit their exposure if losses grow from those levels.[17] Knowing, furthermore, that the resolution authority will not put the BHC into resolution until losses exceed 15 percent of risk-weighted assets, the holders of the UFL will likely run on the BHC. As the run creates fire sales by the BHC, imposing losses on other parties, the resolution of the firm will be messy, and the government may feel the need to bail out the BHC's UFL holders to forestall the run.

In contrast, consider the BHC with both the equity and the debt requirement. In this case, losses of half the previous size will exhaust the BHC's equity. When losses rise from 5 to 6 to 7.5 percent of risk-weighted assets, the holders of the UFL realize that the firm has losses that equal its equity and that it will likely be put into resolution. However, they also recognize that the $75 billion of at-risk debt provides a source of "capital in resolution" that, in the event of the firm's resolution, provides a buffer against further losses from eroding the value of the firm's UFL. Consequently, the UFL holders have little reason to run. As a result, the resolution authority could put the BHC into resolution without triggering a run, allowing a greater chance for an

[14] We are ignoring the fact that if the protection takes the form of equity, the bank will pay higher taxes out of cash flow. This may reduce the retained wealth available for UFL protection.

[15] Equity is more expensive than debt generally because interest is tax deductible. Long-term debt is usually considered more expensive than short-term debt because of the greater uncertainty associated with the longer maturity. In addition, the higher cost of long-term debt may not be offset by lower costs of other liabilities of the firm, in violation of the Modigliani-Miller framework; if there are agency problems (conflicts of interest between shareholders and creditors), creditors may prefer lending with a "short leash"—that is, short-term. Pushing them away from their natural habitat will require a maturity premium that makes long-term debt more expensive.

[16] This assumption is not implausible; in the bank failure data we studied earlier, only two out of 1,619 failures did not entail losses to the FDIC. Prompt corrective action implies in principle that the FDIC should close banks before capital is depleted and the FDIC is exposed to losses. However, as just noted, losses to the FDIC are the rule in FDIC failures. Nonetheless, our assumption can be weakened. What is required is that 1) there are dead-weight costs to resolution that will deplete assets available to pay out to holders of UFL, and 2) the timing of the resolution is uncertain, so that by the time it occurs there is a sufficient probability applied to the outcome that UFL holders will not be made whole in the course of the resolution or that payouts to them will be delayed.

[17] The losses and equity values discussed in this section are all in book terms.

orderly resolution (holding fixed the potential signaling effects on other firms). So if society were to *substitute* long-term at-risk debt for equity, one would expect more frequent failures of firms, but these failures would be less likely to be accompanied by runs on the firm—that is, they would be less likely to be messy. By contrast, if long-term at-risk debt were deployed in *addition* to the minimum regulatory equity capital requirement, then, all else equal, losses that deplete capital would be no more frequent but would be less messy.

In summary, the difference between "loss bearing" capacity in which one is expressed solely as an equity requirement and the other is split between an equity requirement and an at-risk debt requirement is this: An at-risk debt requirement results in more frequent resolutions of BHCs, but these resolutions are more orderly. Essentially, under our assumptions, a requirement consisting solely of equity results in little expected protection for the holders of UFL in those extreme events in which equity is exhausted, resulting in runs on the firm. This, in turn, reduces the chances that resolution can be accomplished in an orderly way, putting greater pressure on the government to bail out the UFL of the firm.

We can make the same point about the benefits of an at-risk debt requirement more generally using some algebra. Consider a model with three dates, $t = 0,1,2,$ and a representative bank with the following balance sheet:

Assets	Liabilities
A	UFL
	LD
	E

The bank has assets worth A, which it funds with UFL, long-term debt, LD, and equity, E.[18] UFL can be redeemed at $t = 1$. Long-term debt can be redeemed only at the last date $t = 2$. All liability-side variables are valued as of date $t = 2$. LD is at risk, or bail-in-able, because it is junior to UFL. That is, in the event of default, long-term debtholders are paid only after UFL debtholders have been reimbursed in full.

We assume that the return on the bank's assets is random and that the bank can suffer losses at dates 1 and 2. In particular, we assume two states of the world: The good state occurs with probability $1 - a$, and the bad state occurs with probability a. If the good state of the world occurs, the bank does not suffer any losses, and the value of its assets is A at $t = 2$. If the bad state of the world occurs, the bank suffers losses L_1 at $t = 1$. Further, if the bad state of the world occurs, with probability $1 - \beta$, the bank does not suffer any further losses at $t = 2$, in which case the value of its assets is $A - L_1$, but with probability β, the bank suffers additional losses L_2 at $t = 2$, in which case the value of its assets is $A - L_1 - L_2$ at $t = 2$.

We now consider two alternative funding structures for the bank in our model:

Case I (all equity): The bank holds no long-term debt, only equity. The bank's balance sheet thus has the following form:

Assets	Liabilities
A	UFL
	$LD_1 = 0$
	E_1

Case II (equity and long-term debt): The bank holds some long-term debt and some equity, where the sum of the two is equal to the equity the bank holds in Case I (all equity). Hence, the bank's balance sheet has the following form:

Assets	Liabilities
A	UFL
	$LD_2 = E_1 - E_2$
	$E_2 < E_1$

We assume that the bank makes the following promises to its UFL creditors: If they withdraw their funds at $t = 1$, they will receive 1 unit; and if they choose to roll over their claims and withdraw their debt at $t = 2$, they will receive the return of $r_s > 1$ at $t = 2$. In order to see UFL creditors' rollover incentives, consider the following scenario: Suppose that $A - L_1 - L_2 < UFL < A - L_1$. Under these conditions, in the bad state of the world, if the bank experiences further losses, it does not have enough funds to pay UFL creditors in full at $t = 2$, whereas the bank can pay them in full at $t = 2$ if it does not experience any further losses. In Case I (all equity) the bank has positive equity $E_1 - L_1 > 0$ at $t = 1$. Suppose that $E_2 < L_1$ so that, under Case II (equity and long-term debt), the bank has negative equity at $t = 1$ in the bad state. Note that, if the probability of the bank experiencing additional losses at $t = 2$ (β) is sufficiently high, UFL creditors will be concerned about the solvency of the bank and decide not to roll over their claims, resulting in a run on the bank.

[18] Note the absence of insured deposits; we show in the appendix that the case for an at-risk debt requirement is even stronger when the bank has insured deposits because insured depositors are senior to UFL creditors and therefore the latter are more likely to run.

We model UFL creditors' rollover decision at $t = 1$ as follows: If a UFL creditor withdraws, he receives 1 unit. If he rolls it over, he expects to receive

$$\beta\left(\frac{A - L_1 - L_2}{UFL}\right) + (1 - \beta)r_s,$$

since with probability $1 - \beta$, the bank does not experience additional losses and an UFL creditor receives the promised amount r_s, and with probability β, the bank experiences additional losses and the creditor receives a pro rata share of the bank's return at $t = 2$ with other UFL creditors. Long-term creditors receive nothing because, by assumption, they hold a junior claim. Hence, the UFL holders will withdraw as long as

$$\beta\left(\frac{A - L_1 - L_2}{UFL}\right) + (1 - \beta)r_s < 1, \qquad (1)$$

that is, when β is sufficiently high:

$$\beta > \frac{r_s - 1}{r_s - \frac{A - L_1 - L_2}{UFL}} = \beta^*.$$ [19]

Hence, for $\beta > \beta^*$, it is optimal for UFL creditors not to roll over their claims, and, consequently, in the bad state, there will be a run on the bank at $t = 1$ unless the regulator intervenes. Note that in the benchmark case, where there is no intervention by a regulator, long-term at-risk debt and equity provide the same level of buffer for losses; they are substitutes.[20] Next, we modify the benchmark case to show how long-term debt and equity can have different effects once regulatory intervention is possible.

Suppose that a regulator intervenes if, and only if, the bank has negative equity.[21] We assume the regulator can make this decision before UFL creditors decide whether they will roll over their debt (say, at $t = 1/2$).

Then, at $t = 1/2$ in Case I, where the bank has all equity, the bank has a positive equity of $E_1 - L_1 > 0$, so that the regulator leaves the bank open. However, for $\beta > \beta^*$, the probability of further losses is large enough that UFL creditors do not roll over, resulting in a run on the bank.[22]

[19] Note that we are assuming depositors are risk neutral. If they were risk averse, the threshold for running would differ.

[20] To see that explicitly, substitute the balance sheet identity $A = UFL_2 + LD_2 + E$ into (1).

[21] To be clear, the meaning here is book value of equity, not market value.

[22] One can argue that the regulator can intervene if it anticipates a run, even though the bank may have positive equity at the moment. We can extend the model and allow the value of β to be uncertain, either high or low, and in expectation the bank can pay all wholesale creditors (or has positive equity) so that the regulator does not intervene. But once the high value of β is realized, the run starts, and it is too late for the regulator to intervene to prevent it.

To contrast, consider Case II, where the bank has some equity and some long-term debt. Since in the bad state of the world the bank's equity is already wiped out ($E_2 - L_1 < 0$), the regulator has to intervene. The long-term debt (by providing, in the event of resolution, a loss absorber in front of the uninsured financial liabilities) allows the regulator to take the "right" action (when it follows a rule of intervening when the capital has been wiped out).

The analysis above suggests that an at-risk debt requirement can add to the stability of a BHC by preventing runs by UFL creditors. It should be noted that more frequent (but more orderly) resolutions would be expected only if an at-risk debt requirement were put in place at the expense of a lower equity requirement. However, if the at-risk debt requirement were met by substituting UFL with long-term debt, then there would be no expectation of more frequent resolutions.

Next, we show that the amount of long-term debt should be increasing in the amount of UFL the bank uses for the same level of the threshold value β^*. To perform the analysis, we fix the equity of the bank at $\overline{E}$ and change UFL and LD. In particular, for the same level of β^*, we obtain

$$d\beta^* = \frac{\partial\beta^*}{\partial UFL}\, dUFL + \frac{\partial\beta^*}{\partial LD}\, dLD = 0.$$

Using $\beta^* = \frac{r_s - 1}{r_s - \frac{A - L_1 - L_2}{UFL}}$ and the balance sheet identity $A = UFL + LD + \overline{E}$, we can show that

$$sign\left(\frac{\partial\beta^*}{\partial UFL}\right) = sign\left(-(r_s - 1)(LD + \overline{E} - L_1 - L_2)\right),$$

which is negative, and

$$sign\left(\frac{\partial\beta^*}{\partial UFL}\right) = sign\left(UFL(r_s - 1)\right),$$ which is positive.

Hence, we have $\frac{dLD}{dUFL} = \frac{\partial\beta^*/\partial UFL}{\partial\beta^*/\partial LD} > 0.$
If the bank wants to increase UFL, it needs to hold more long-term debt for the same level of bank stability (as measured by the likelihood of runs by UFL). We can perform the same analysis where we keep the equity of the bank fixed as a fraction of the bank's assets. In that case, we obtain similar results, but the required increase in long-term debt is less compared with the previous case. This is because when the bank's balance sheet expands due to an increase in UFL, its equity increases (while keeping the capital ratio constant). The increase in the bank's equity provides some cover for the holders of UFL, and the required increase in long-term debt can be less compared with the previous case.

Recall that we had three points to make about the benefits of an at-risk debt requirement. We now turn to the second: the internalization of an externality. While banks produce a socially valuable, money-like service when they issue UFL, they may create too much of a good thing. As Stein (2012) and others have noted, there are externalities associated with the production of short-term debt; banks capture the social benefit of the production of short-term debt, but they do not always internalize its costs—namely, fire sales.[23] In the event of, or anticipation of, a crisis, banks are forced to "fire sale" assets to meet their short-term obligations, a move that can exacerbate the crisis by weakening the solvency of banks with similar assets. As Stein (2012, p. 2) explains, "banks may engage in excessive money creation, and may leave the financial system overly vulnerable to costly crisis."

Requiring banks to issue long-term at-risk debt in proportion to their financial liabilities can force banks to internalize the external costs associated with UFL issuance. The at-risk debt requirement forces banks to deviate from their privately optimal liability structure (because long-term debt is costlier than short-term debt), and, under our proposal, the required deviation is increasing in the amount of UFL. Thus, banks are inclined to be less reliant on UFL in their balance sheet choices.

The third potential benefit of an at-risk debt requirement is that debt can provide a useful signal of risk to supervisors. As Gropp, Vesala, and Vulpes (2006) point out, market indicators, such as spreads on debt, have the advantage of being more frequently observed and more forward-looking than accounting data. Bond spreads, in particular, have the advantage over equity prices in that spreads are not increasing in volatility as an institution nears default; bond spreads represent the downside perspective of supervisors and the FDIC. Gropp, Vesala, and Vulpes (2006) show that both subordinated bond spreads and equity prices help predict bank downgrades, but at different horizons. Both have marginal predictive power compared with bank accounting data.

5. Discussion

To reiterate, we have said that at-risk debt plays the role of capital in the resolution of a firm. We have said also that basing the at-risk debt requirement on the amount of UFL issued by a firm serves the purpose of providing additional capital in resolution for those firms whose failure would likely be the messiest (because of the high level of UFL among their liabilities). Given that long-term debt is costlier than short-term debt, the at-risk debt requirement would also provide an incentive for firms to reduce their reliance on UFLs.

Consider a large financial firm whose liabilities consist solely of insured deposits, with a large amount of equity. In our suggested rule for at-risk debt shown above, the firm would have a zero requirement of long-term debt. Is that reasonable? We would argue that it is reasonable because the liability structure of the firm would resemble a small bank whose failures are not typically messy (recall that all the firms we are discussing are subject to prudential regulation and supervision). Since insured deposit holders are not prone to run, the failure itself is unlikely to be extremely messy. In this case, the deposit insurer would provide the "capital" in resolution of the firm.

What would our proposal for basing an at-risk debt requirement on the amount of UFL issued by a firm imply about the amount of long-term debt large banks would have to issue? Calibrating the requirement is beyond the scope of this article, but conceptually we are proposing a rule of the form

$$LTD_i = aUFL_i.$$

Chart 4 plots the amount of UFL per assets as of the fourth quarter of 2012 for the set of twenty-two BHCs with more than $100 billion in assets. The chart shows considerable variation in reliance on UFL, so the amount of at-risk debt required, per dollar of assets, would vary accordingly across BHCs.

In practice, given the complexity of the large financial firms, it is difficult to measure precisely how much UFL a firm has issued, because for some liabilities it is not perfectly clear whether they are "financial" liabilities or exactly how runnable they are (for example, it may be unclear what proportion of its commercial paper a firm would buy back). Consequently, it may be preferable to base an at-risk debt requirement on the size of the firm as measured by either total assets or risk-weighted assets combined with the amount of UFL they issue, or make the requirement the greater of the two, such as a requirement expressed as

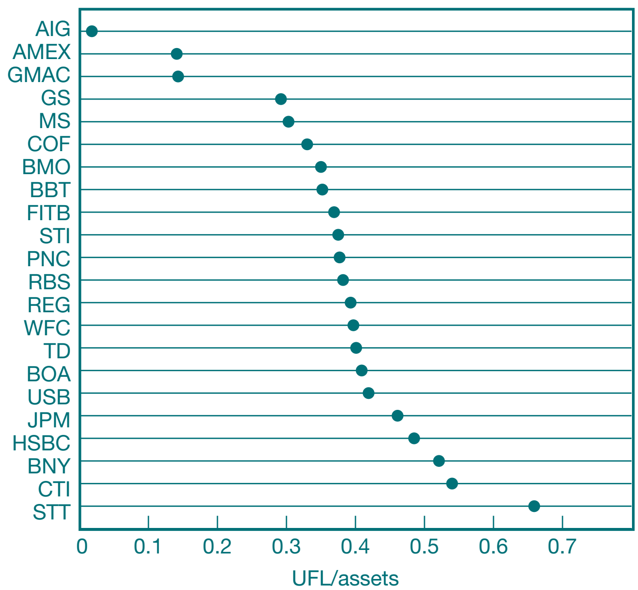
$$LDT_i = \min\{aUFL_i, b\,Total\ Assets\}.$$

The parameters a and b can be chosen to make sure that, in the event of a firm's failure, the resolution authority

[23] The short-term debt emphasized in Stein (2012) seems very close to our concept of UFL. See also Gorton and Metrick (2010), Gorton and Pennacchi (1990), and Holmström and Tirole (1998, 2011).

Chart 4

UFL to Assets at the Largest BHCs



Source: Board of Governors of the Federal Reserve System, *Consolidated Financial Statements of Bank Holding Companies* (FR Y-9C data).

Note: The largest BHCs have total assets more than U.S.$100 billion, according to the FR Y-9C in 2014:Q4.

would have sufficient long-term at-risk debt on hand to provide capital that would cover a variety of scenarios regarding the firm's asset values.

The large firms we discuss are most often organized as a holding company with many subsidiaries. How would the at-risk debt requirement apply to a bank holding company? One possibility would be to measure, at each subsidiary, the amount of UFL that the subsidiary has issued to third parties. The holding company would then be required to issue at-risk debt in the amount of a multiplied by the total UFL issued by all of the firm's subsidiaries. In turn, the subsidiaries could borrow from the holding company an amount of long-term debt equal to a multiplied by the UFL issued by the subsidiary. This arrangement would be consistent with the single point of entry receivership approach to resolution that the FDIC has proposed.[24] Under that approach, the FDIC would take only the holding company into resolution, with the intention of maintaining the operating subsidiaries as going concerns. The at-risk debt of the holding company would be converted into equity of the bridge company. The bridge holding company could forgive the long-term debt of the separate subsidiaries, as needed, to provide them with additional capital.

[24] See http://www.fdic.gov/about/srac/2012/2012-01-25_resolution-strategy.pdf. Accessed August 22, 2013.

6. Conclusion

If the Lehman Brothers bankruptcy proved anything, it was that large bank failures are *messy*; they destroy value, they consume legal resources, and, not least, they spill over to other financial institutions and cause more widespread instability. This article has suggested a unifying framework for understanding why large bank failures are so messy. The reason for the messy failures, we have argued, is banks' heavy reliance on uninsured, money-like *financial liabilities*, such as uninsured deposits, repos, trading liabilities, commercial paper, and the like. The liquidity services of those liabilities get destroyed in failure, and the holders of those uninsured liabilities are prone to run as the bank approaches failure, which can cause fire sales. Both of these consequences make large bank failures messy.

We provide simple, direct evidence for our thesis. First, we show that failed banks that relied more on uninsured financial liabilities in the year prior to their failure experienced greater contractions in uninsured financial liabilities over the ensuing year. This finding is consistent with the hypothesis that holders of uninsured financial liabilities are prone to run. Second, we show that the cost of bank failures to the FDIC was increasing in the amount of uninsured financial liabilities in the year before the crisis. We take that finding as consistent with the premise that distressed banks' heavy reliance on uninsured financial liabilities subjects them to runs and fire sales, which increases the cost of the failure. That is, it makes the failure messier (although our regression does not capture the spillover to other institutions).

We join Calello and Ervin (2010), the European Commission (2012), Tarullo (2013), and others in recommending a long-term "at-risk" debt requirement as an additional measure to help cope with the problem of large banks' messy failures. Having such debt convertible to equity at failure provides a form of capital in resolution that can, in principle, stall runs by uninsured liability holders. Furthermore, sizing the requirement by the amount of uninsured financial liabilities, as we recommend, helps internalize the external costs (the risk of fire sales) of issuing money-like uninsured financial liabilities.

While we recommend an at-risk debt requirement as a way to deal with messy bank failures, we realize that such a requirement is not a panacea. First, it is not entirely clear how thick the market would be for at-risk, or "bail-in-able", debt; the peculiarities of pricing such an instrument could hamper its development. Second, there is the potential for unstable market dynamics associated with an at-risk debt requirement. Even a small rumor about losses at a large bank could cause issuers' debt prices to collapse and make it difficult for the bank to issue new debt, which would potentially create a crisis for the firm. So the issuance dynamics must be carefully considered when requiring periodic issuance by a firm. Firms should not be put into resolution solely because of temporary disruptions in the market for their long-term debt. Finally, this proposal, like many others, does not prevent the buildup of systemic risk and the experience of contagion and contagious defaults among firms. Consequently, we think that this single approach, like all other approaches, cannot by itself eliminate the too-big-to-fail problem. Instead, we think this approach is an effective step in the right direction to limit the most damaging feature of too-big-to-fail financial firms: the fragility inherent in their reliance on uninsured financial liabilities.

To be clear, we are recommending an at-risk debt requirement as a supplement—not a substitute—for other macroprudential regulations, including equity capital requirements. In our discussion and argumentation, we needed to consider the argument of whether $2x$ in equity was as effective in limiting the messiness of large financial firms' failures as x in equity and x in long-term at-risk debt. However, we conclude that at-risk debt and equity are not substitutable. In particular, we do not suggest that at-risk long-term debt should serve to fulfill equity capital requirements, nor do we suggest that equity be allowed to fulfill the at-risk long-term debt requirement. Our view is that at-risk long-term debt should substitute for uninsured financial liabilities, not equity capital.

Appendix

Insured Deposits

Suppose now that the bank funds a portion of its assets with insured deposits, *ID*. In this case, the bank balance sheet has the following form:

Assets	Liabilities
A	ID
	UFL
	LD
	E

Further assume that *ID* is senior to all other creditors in bankruptcy. Suppose that $A - L_1 - L_2 < ID + UFL$ and $ID + UFL < A - L_1$. Hence, in the bad state of the world, if the bank experiences additional losses, it will not have enough funds to pay all insured depositors and the *UFL* creditors in full at $t = 2$, whereas it can pay them in full at $t = 2$ if it does not experience additional losses.

Assuming that *UFL* holders follow a rollover decision at $t = 1$ similar to that adopted in the benchmark case, they will withdraw if

$$\beta\left(\frac{A - L_1 - L_2 - ID}{UFL}\right) + (1 - \beta)r_s < 1,$$

that is, if β is sufficiently high:

$$\beta > \frac{r_s - 1}{r_s - \frac{A - L_1 - L_2 - ID}{UFL}} = \beta' < \beta^*$$

Hence, for $\beta > \beta'$, it is optimal for UFL holders to withdraw at $t = 1$ in the bad state of the world, triggering a run on the bank (unless the regulator intervenes). Note that β' is decreasing in *ID*.

In the presence of insured deposits, the run threshold for the probability of further losses is lower compared with the benchmark case, that is, $\beta > \beta'$. Hence, UFL creditors are more likely to run at $t = 1$ when the bank suffers losses of L_1. The reason is that the UFL creditors are junior to insured depositors in bankruptcy so that, compared with the benchmark case, *UFL* recover less in bankruptcy (and even less so when the bank has more insured deposits). As a result, early intervention by the regulator is even more important, and the conclusions of the benchmark case about the desirability of long-term debt are strengthened.

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