Size and Risk-taking of Financial institutions

Abstract

We investigate the link between firm size and risk-taking among financial institutions during the period of 1998-2008 and make four contributions. First, size is positively correlated with risk-taking measures even controlling for other observable firm characteristics such as market-to-book asset ratio, corporate governance and ownership structure. This is consistent with the notion that "too-big-to-fail" policies distort the risk incentives of financial institutions. Second, a simple decomposition of the risk measure, z-score, reveals that financial firms engage in excessive risk-taking mainly through leverage. Third, we find that the recently developed governance variable, measured as the median director dollar stockholding, has a substantial impact on reducing firm risk taking. Lastly, investment banks are generally riskier than commercial banks. These findings suggest that rather than capping the firm size, it is more effective for policymakers to control financial firm's risk-taking by strengthening regulations on capital requirement; they also provide justification for the functional separation of investment banking from wholesale financial services; in terms of corporate risk management policy, these findings suggest that the excessive risk-taking problem can potentially be attenuated by focusing on the governance structure.

JEL classification: G01, G28, G34

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1. Introduction

"Too-big-to-fail policies offer systemically important firms the explicit or implicit promise of a bailout when things go wrong. These policies are destructive, for several reasons. First, because the possibility of a bailout means a firm's stakeholders claim all the profits but only some of the losses, financial firms that might receive government support have an incentive to take extra risk. The firm's shareholders, creditors, employees, and management all share the temptation. The result is an increase in the risks borne by society as a whole."

———— The Squam Lake Report: Fixing the Financial System

Too-big-to-fail (TBTF) is a concept when governments have to bail out a failing financial institution because its failure may have severely adverse effect on the economy. When firms are perceived TBTF, they may have a propensity to assume excessive risks to profit in the short term. Indeed, TBTF policy has been blamed by many, including the Obama administration, as one of the main factors causing distortion in financial firms' risk-taking incentives, which played a pivotal role in the recent financial crisis. The risk distortion emanated from TBTF policies are often referred to as "moral hazard" problem in finance literature[1].

In turn, policy makers propose an array of regulations to reshape financial institutions. Specifically designed to address the TBTF issue, suggestions such as limiting the size of financial institutions have been proposed by the Obama administration along with academics[2]. The reason for dealing with size directly is that it is believed by the regulators that the larger the firm is, the more likely it is systematically important or TBTF[3]. On the one hand, proponents of such proposal argue that it will deter financial firms becoming so large that they put the broader economy at risk and distort normal competitive forces. Indeed, Baker and McArthur (2009) estimate the gap of funding cost between small and TBTF firms averaged 0.29 percentage points

[1] see Boyd, Jagannathan and Kwak (2009) for a detailed description of this problem

[2] See, for example, "Proposal Set to Curb Bank Giants", Wall Street Journal, January 21, 2010, A2. Boyd, Jagannathan and Kwak (2009) and Walter (2009) also propose size limits on firms.

[3] We use the term TBTF and systematically important interchangeably hereafter.

in the period from 2000 through 2007 and this gap has widened to an average of 0.78 percentage points from 2008 through 2009. Rime (2005) finds that the TBTF status has a significant, positive impact on bank issuer ratings. On the other hand, there are many problems associated with this reform. First of all, it is practically impossible to determine the correct size threshold; secondly, this simple size metric will still miss many small firms that perform critical payment processing and pose significant systemic risk, even the first issue can be solved (Stern and Feldman, 2009). In addition, opponents of such proposal often cite the literature on scale of economy and are concerned such restraint would weaken the global competitiveness of U.S. financial industry and cause loss of market share. Further, Dermine and Schoenmaker (2010) argue that capping the size is not the best tool, based on the finding that countries with relatively small banks faced large bailout cost; in addition, they caution that capping the size can have an unintended effect such as a lack of credit risk diversification.

Is size the problem? This paper attempts to shed light on the issue by studying the size effect on risk-taking of financial institutions, including commercial banks, investment banks and life insurance companies. Using data on the size and risk-taking of financial institutions from 1998 to 2008, we investigate whether cross-sectional variation in the scale of firms is related to heterogeneity in risk-taking. It is worth noting at the outset that, while we ambitiously attempt to identify a causal effect of firm size on risk-taking, we do not claim evidence of causal effect of firm size on risk-taking due to the potentially omitted confounding covariates. Our measures of risk-taking are comprehensive. It includes a model-based measure such as z-score[4], an

[4] z-score measures distance to default and higher z-score implies more stability. It is calculated as the sum of return on asset and capital asset ratio divided by volatility of asset return. See Boyd and Runkle (1993) for a theoretic development of this variable. z-score has been used extensively as a measure of bank risk recently; see, for example, Boyd, De Nicolo, and Jalal, 2006; Laeven and Levine, 2009; Houston, et al, 2010; Beltratti and Stulz, 2010.

accounting-based measure such as volatility of return on assets, and a market-based measure such as volatility of stock returns. We primarily focus on z-score; the other risk measures serve as robustness check. Our baseline analysis is to regress z-score on firm size along with other firm characteristics.

If size does affect risk-taking as measured by z-score, then an interesting question is: How does size affect components of z-score? This question is interesting because if we can find out what factors might drive the relation between firm size and risk-taking, we can target the risk-taking problem of financial institutions more directly. We argue that if limiting the size focuses on exclusively the normative aspects of the issue of risk-taking, then the factor analysis would address the positive aspects of the problem. We answer this question by regressing each of the components of z-score on firm size and other firm characteristics.

Motivated by proposals which would treat TBTF firms differently[5], we also investigate whether TBTF firms behave differently from small firms as a natural extension to our baseline analysis. We employ a differences-in-differences type regression. We first define firms as TBTF when they pass commonly agreed size threshold, for example, $10 billion in assets, then interact TBTF firm dummy with size. We establish the following findings. First, firm size is positively correlated with risk-taking even controlling for observable firm characteristics such as market-to-book ratio and ownership structure, which are believed have an effect on risk-taking. For instance, a one-standard deviation increase in size will increase z-score by 3 points. The analysis of decomposing z-score reveals that firm size has a significant, negative impact on capital asset ratio, but not on return on asset or earnings volatility. These findings suggest that financial firms

[5] For example, Obama administration proposes using tax policy to punish large banks based on their exposure to risk. See "White House's Tax Proposal Targets Big Banks' Risks", Wall Street Journal, January 14, 2010.

engage in excessive risk-taking mainly through increased leverage. On the other hand, they also suggest that economy of scale does not exist, which is consistent with existing literature. Regressions with volatility of stock return as dependent variable also yield interesting results. We find evidence that size related diversification does exist in the financial sector since size is negatively associated with volatility return.

Second, we find that the newly developed corporate governance measure, calculated as median director dollar stockholding, is negatively associated with risk-taking for all risk measures, and they are significant at 1% level across all specifications and all estimations. Lastly, we find that investment banks engage in more risk-taking compared to commercial banks and insurance companies are not.

While there is a substantial literature that examines the risk-taking behavior of financial institutions (see Saunders, Strock and Travlos 1990, Demsetz, Saidenberg and Strahan 1997, Stiroh 2006, Laeven and Levine 2009, and Houston et al 2010), to our knowledge, we are the first to study comprehensively the relation between size and risk-taking of financial institutions (see Table 1 for a detailed comparison of this study with existing literature on risk-taking of financial institutions). The gap is surprising because the too-big-to-fail phenomenon is not new at all[6] and one might think this question must have been settled a long time ago. While Boyd and Runkle (1993) is the closest to this study, there are significant differences. First, the motivation is different. Their study is motivated by two theories related to banking firms: deposit insurance and modern intermediation theory, while ours is motivated by the political debate about capping the financial firm's size. Secondly, the scope of their study is limited by focusing on only large

[6] The existence of TBTF policy was first admitted by federal government in 1984 when the Comptroller of the Currency contributed roughly $1 billion to save Continental Illinois Bank from default. See Morgan and Stiroh (2005).

bank holding companies (BHCs), our sample includes commercial banks, investment banks and insurance and this has a large variation in size. We argue that, since recent financial crisis was not caused by bank holding companies alone, excluding these important components will not provide a complete picture about risk-taking in the financial industry. Lastly, the inference of their study is also limited because in their empirical test, the only explanatory variable is size which is more like a univariate analysis, while ours include covariates which in theory might affect firm's risk-taking. Another paper which is close to ours is Demsetz and Strahan (1997), who provide evidence that diversification and size are highly correlated in BHCs. Since BHC size is not correlated stock return variance in many years of their sample period, they conclude that size-related diversification does not translate into reductions in risk. In their regression analysis, however, they find that firm size has significant effect in reducing firm-specific risk.

Our study also contributes to the broader literature on governance (see Gompers, Ishii and Metrick, 2003; Bebchuk, Cohen and Ferrell, 2009; and Brown and Caylor, 2006) by incorporating a new measure of corporate governance, namely, the median director dollar stockholding (see Bhagat and Bolton, 2008), and by offering empirically evidence that the new measure has a significant impact in reducing risk-taking of financial institutions.

Our analysis is crucial from a public policy perspective because risk-taking behavior of financial institutions affects financial and economic fragility, business cycle fluctuations, and economic growth (see Bernanke, 1983, Calomiris and Mason, 1997, 2003a, b, and Keely, 1990). Our findings have important policy implications particularly relevant today, as calls for strict restrictions and reinforcement of corporate governance on financial sector accelerate[7]. First, they suggest that instead of capping the firm size, it is more effective for regulators to strengthen and

[7] See The Art and Science of Risk Management, 2009 Federal Reserve Bank of Chicago Annual Report.

enhance regulations on capital requirements for all financial institutions. Secondly, our finding on corporate governance indicates that median director dollar stockholding can be used as an effective internal corporate risk control mechanism. Our last finding provides justification for the functional separation of investment banking from wholesale financial services, as pointed out by Walter (2009).

The paper is organized as follows. In Section 2, I review the existing literature and develop the hypotheses. Section 3 summarizes the data. Section 4 presents core results. Section 5 compares the marginal effect of size on risk-taking between TBTF firms and non-TBTF firms. Section 6 concludes with policy implications.

2. Literature review and hypotheses development

Recent financial crisis has generated tremendous interest in the study of risk-taking of financial institutions (FIs). A variety of issues have been considered by researchers. For instance, in a cross county study, Laeven and Levine (2009) analyze the relation between bank risk-taking, bank governance (measured by cash flow rights), and national bank regulations. Specifically, they investigate how governance and national regulations jointly shape the risk-taking behavior of individual banks. Base on a sample of the largest 279 banks in 48 countries, they found that cash flow right plays a critical role in shaping bank's risk-taking to the extent that actual sign of the effect of regulation on risk varies with ownership concentration. Beltratti and Stulz (2010) exploit variation in the cross-section of performance of large banks across the world during the period of the financial turmoil. They document that banks with dispersed ownership have lower idiosyncratic risk and banks with more non-interest income is associated with higher idiosyncratic risk. Based on a U.S. sample of FIs, Cheng, Hong and Scheinkman (2010) investigate whether compensation structure contributes to excessive risk-taking. They find that risk-taking, measured as firm beta, return volatility, etc, are correlated with short-term pay such as options and options. Surprisingly, their main result suggests that, besides the greediness of management, investors' short-termism may also have contributed to the crisis by encouraging management to engage in excessive risk-taking.

We focus on size-related risk distortion in this study; we construct a few hypotheses drawn from the moral hazard and risk-taking literature. This first is the view of moral hazard in financial firms due to the TBTF policies. Moral hazard is a concept that refers to distortion of incentives caused by insurance; it occurs when a party insulated from risk may behave differently than it would behave if it were fully exposed to the risk. In banking, this distortion of behavior may happen for a variety of reasons such as protection of bank creditors provided by the Discount Window, deposit insurance, and especially the TBTF policy. With government safety net in place, the downside risks of FIs are limited: TBTF firms know they will be bailed out by passing their losses to the government and taxpayers when their bets go sour while keeping all the profits when gambles succeed. Since firm size is positively correlated with the likelihood of being TBTF, it follows that, as firms become larger, they are more likely to engage in excessive risk-taking. This strand of literature includes Boyd and Runkle (1993), Boyd, Jagannathan and Kwak (2009), Walter (2009), to name just a few.

The role of corporate governance in coping with risk is not obvious. Standard theory on corporate governance predicts that firms with better governance increases firm value by adopting projects with positive net present value (NPV)[8]. However, it doesn't preclude the possibility of projects with risky cash flows. Therefore, it might be in the interest of shareholders to take risky

[8] Gompers, Ishii and Metrick (2003) provide evidence that firms with better governance have higher firm value; Bhagat and Bolton (2008) have similar findings.

projects as long as they are value-enhancing. In addition, option theory (Black and Scholes, 1973) tells us that, all else being equal, the value of option increases with volatility of the underlying asset. Since a company's shareholders are essentially holding a call option with the total value of the company as underlying asset, and the value of debt as striking price (assuming the firm has risky debt), it follows that the more volatile the company's cash flow is, the more valuable the call option is. Thus, the value of common stock increases. Based on these arguments, we would expect a positive association between corporate governance and risk-taking.

This relation, however, can go the opposite direction. As Rajan (2006) and Diamond and Rajan (2009) pointed out, the compensation structure is different in finance industry in that the performance of CEOs is evaluated based in part on the earnings they generate relative to their peers. With this pressure, executives have incentives to take excessive risk to profit in the short run even if they are not truly value-maximizing —— a term coined "short-termism" in banking literature (see Cheng, Hong, and Scheinkman, 2010). As noted in Diamond and Rajan (2009), "even if managers recognize that this type of strategy is not truly value-creating, a desire to pump up their stock prices and their personal reputations may nevertheless make it the most attractive option for them". If these researchers are right, we would expect FIs with better governance to have set incentives and controls to avoid taking risks that did not benefit shareholders. Thus, we should see a negative relation between corporate governance and risk-taking[9]. We argue that Diamond and Rajan (2009) is more relevant to our study since their study is specifically tailored to financial institutions; we expect a negative association between corporate governance and risk-taking.

[9] Indeed, as argued by John, Litov, and Yeung (2008), the relationship between corporate governance and risk-taking could be either positive or negative.

The third hypothesis is based on the fact that commercial banks and insurance companies have relatively stricter regulations comparing with investment banks, so we expect that risk-taking of commercial banks and insurance companies is more constrained. The last one is motivated by the proposed differential treatment of big vs. small firms, and it extends the first hypothesis and argue that firm in different size cohort behave differently. These hypotheses are summarized as the followings:

H1. *On average, bigger FIs are riskier than small FIs. The exact size beyond which government will bail out the troubled firm is unknown, but generally we expect the likelihood of government rescue is bigger for large FIs than small FIs.*

H2. *The effect of corporate governance on firm risk-taking is negative.*

H3. *Investment banks are riskier than commercial banks.*

H4. *Conditional on whether a FI is TBTF firm, the marginal effect of size on risk is higher for systemic important firms than non-systemic firms.*

3. Sample collection and variable construction

Our main sources of data are Compustat, Center for Research in Security Prices (CRSP), and RiskMetrics supplemented by hand-collected data from company's proxy statement on EDGAR. We define financial industry as all financial institutions consisting of commercial banks, investment banks and life insurance[10], as classified by their 4-digit standard industrial classification (SIC). Specifically, firms with the 4-digit SIC codes of 6020, 6211 and 6311 are

[10] We would like to include mortgage companies such as Fannie Mae and Freddie Mac in our sample, but the observations for these firms are too small to make reliable inference.

identified as commercial banks, investment banks and life insurance, respectively[11]. We use this narrower classification on the ground that it greatly reduces unobservable heterogeneity among firms within each category, thus alleviate omitted variable bias and enhances comparability.

The starting point for the sample selection is the Compustat, where we collect annual accounting data on all U.S. commercial banks, investment banks and life insurance. Our sample spans the period 1998-2008. Following Boyd and Runkle (1993) and John, Litov and Yeung (2008), we require that firms have at least five years of data on key accounting variables over the period to be included in the sample. This process yields our initial sample of 687 unique financial institutions or an unbalanced panel of 6180 firm-year observations, comprising 587 commercial banks, 59 investment banks and 41 life insurance companies.

Our study requires governance and CEO ownership data. This data is available through RiskMetrics. However, RiskMetrics only provides data for S&P 1500 companies. After matching our initial sample with this database, we lost majority of our observations[12]. For this reason, we hand-collect data on governance and ownership from each company's proxy statement. However, extracting data on all 687 firms is labor intensive, so we limited our investigation to a random sample of 250 commercial banks, while keeping all the investment banks and life insurance from original sample. The advantage of the sampling process is that it avoids the estimation problem of selection on observables (size) since firms in S&P 1500 are relatively large. We then match this random sample to CRSP to retrieve the stock return data in order to calculate stock return volatility. Our final sample reduces to a total of 302 observations with available data, consisting of 238 commercial banks, 38 investment banks and 26 life insurance

[11] This classification is similar to Cheng, Hong and Scheinkman (2010)
[12] There are only 10% financial firms in S&P 1500.

companies[13]. In our sample, insurance companies include firms such as AIG, Prudential Financial Inc, and Lincoln National Corp, while investment banks include Bear Stearns, Lehman Brothers, and Goldman Sachs.

3.1. Definition of variables

3.1.1. risk taking

Our primary measure for firm risk-taking is the z-score, which equals the return on assets (ROA) plus the capital asset ratio (CAR) divided by the standard deviation of asset returns (σ(ROA)).

Z-score has been widely used in the recent literature as a measure of bank risk. The z-score measures the distance from insolvency. A higher value of Z-score indicates more stability. Since the Z-score is highly skewed, we follow Laeven and Levine (2009) and Houston et al (2010), and use the natural logarithm of the Z-score as the risk measure. But the problem with this transformation is that it does not work when you have non-positive z-scores, which will render some loss of observations. Due to this reason, we rely on raw z-score as our primary measure for risk taking while taking into account the skewness of the distribution as we perform regression analysis, and use logarithm of z-score as a robustness check. The ROA and CAR are calculated as the average over 1998-2008 using annual data, and σ(ROA) is the standard deviation of annual ROA over 1998-2008.

In order to gain insights about which component of the z-score is principally driving the relationship between independent variables (e.g., size, ownership, and corporate governance) and

[13] For comparison, our random sample includes 70% of the Fahlenbrach and Stulz (2009) sample, where they have 98 observations.

z-score, we use the three components of z-score (i.e., ROA, CAR, and σ(ROA)) as separate dependent variables. As a further robustness check, we also use standard deviation of annual stock return over our sample period as an alternative measure of risk.

3.1.2. firm size

The potential candidates for measuring firm size include accounting based measures such as total asset and total revenue, and market based measure such as market capitalization. We prefer total asset and total revenue to market capitalization because previous literature argues these two accounting measures are less noisy as a proxy for the "scale" of the firm than market measure (see Baker and Hall, 2004)[14]. Following the existing literature, we primarily focus on total asset and use total revenue as a robustness check. We apply logarithm transformation on both the average total asset and average total revenue over 1998-2008. We expect the effect of this variable on risk taking to be positive.

3.1.3. corporate governance

The commonly used governance measures are G-index (Gompers, Ishii, and Metrick, 2003), E-index (Bebchuk, Cohen, and Ferrell, 2004) and Gov-Score (Brown and Caylor, 2006). Though these governance indices are widely used in empirical research, such use has both strengths and weaknesses. In particular, recent studies (e.g., Bhagat, Bolton, and Romano, 2008; Bhagat, and Bolton, 2008) have questioned whether governance indices measure the right governance attributes. As such, we employ a new measure of corporate governance, the median director dollar stockholding, developed by Bhagat and Bolton (2008). The advantage of this measure is that it is simple, intuitive, less prone to measurement errors and can enhance the comparability of

[14]Nevertheless, we also tried total market capitalization as measure for firm size in an unreported regression. The results are qualitatively the same as our primary size measures and they are available from authors upon request.

research findings[15]. As mentioned earlier, RiskMetrics provide limited data on financial firms (123 out of 302 observations), so we supplement it by hand-collecting director ownership information, as of the last year over our sample period, from companies' proxy statements. We then calculate the natural logarithm of median director dollar stockholding by matching this data to stock price information obtained from CRSP.

3.1.4 CEO stock ownership

Following Bhagat and Bolton (2008), we use CEO ownership as our measure for bank ownership structure. Like the governance variable, we hand collect CEO ownership in addition to the data provided by RiskMetrics, as of the last year in our sample period, from company's proxy statement.

Risk-averse managers, whose employment income is tied to changes in firm value, have incentives to take on less than optimal firm risk to protect their firm-specific human capital. This is an agency problem in essence as described in Jensen and Meckling (1976), Amihud and Lev (1981), and Smith and Stulz (1985). However, ownership by managers may be used to induce them to act in a manner that is consistent with the interest of shareholders. Thus, we would expect to see a positive relation between CEO ownership and risk-taking. Researchers have documented the impact of ownership structure on firm risk-taking. For instance, analyzing nonfinancial firms, Agrawal and Mandelker (1987) find a positive relation between security holdings of managers and the changes in firm variance, while John, Litov, and Yeung (2008) find that managers enjoying large private benefits of control select suboptimally conservative investment strategies. Saunders, Strock, and Travlos (1990) find the stockholder controlled banks

[15] See Bhagat and Bolton (2008) for a detailed description about this variable.

exhibit higher risk taking behavior than managerially controlled banks. Recent study by Laeven and Levine (2009) considers the potential conflicts between managers and owners and analyze the relations between the risk taking of banks, their ownership structures, and bank regulations. They find that bank risk is generally higher in banks that have controlling shareholders with large banks.

3.1.5 Market-to-book ratio

Market-to-book asset ratio, has been identified an important risk factor in the asset pricing literature. For instance, Fama and French (1992) point out that firms with high ratios of book to market value (or low market-to-book) are more likely to be in financial distress. We compute this variable by averaging each firm's year-end market-to-book asset ratio over the sample period.

In the banking literature, this variable has often been used as a proxy for bank charter value (see Demsetz, Saindenberg and Strahan 1997, and Goyal 2005). A charter has value because of barriers to entry into the industry and usually it is defined as the discounted stream of future profits that a bank is expected to earn from its access to protected markets[16]. Since loss of charter imposes substantial costs, it is argued that charter value can incentivize banks to adopt prudent decision——so-called charter-value hypothesis (see Keeley, 1990; Carletti and Hartmann, 2003). Empirical models of bank risk have been focused on this disciplinary role of charter value. Based on a sample of 367 bank holding companies from 1991-1995, for instance, Demsetz, Saidenberg and Strahan (1997) found that charter value is negatively associated with bank risk-taking. Galloway, Lee and Roden (1997) also found that banks with low charter value assumed significantly more risk.

[16] See Hellmann, Murdock, and Stiglitz (2000) for a description of this variable.

3.1.6 other control

We use average annual return on asset as a control for firm's profitability and debt/asset ratio as a control for firm's leverage. We expect a negative association between profitability and risk-taking, and positive association between risk-taking and leverage.

3.2. Summary statistics

Table 2 presents the summary statistics for all of the key variables. The variable definitions and the data sources are described in Appendix A. In this table, I also separate the sample into three subsamples according to their classification for easy comparison. Summary statistics in Table 2 shows that the z-score has a mean of 34.075 and a standard deviation of 30.824. This fairly high standard deviation and the wide range in z-scores suggest that there is a considerable cross-sectional variation in the level of firm risk. Further, since the average z-score is greater than its median, we know it has a right skewed distribution. Also noticeable is that investment banks have the lowest average z-score followed by commercial banks, and insurance companies have the highest z-score. Since higher z-score means more stable, it seems that investment banks are riskier than its peers, which holds up to our initial conjecture (this point is later confirmed in our regression analysis). The other two measures of risk, volatility of return on asset and equity return, also indicate the same pattern. In terms of leverage, commercial banks are the highest as expeced, followed by insurance and investment banks. Lastly, the summary statistics for z-score are similar to those reported by Houston et al (2010), where they report a mean log z-score of 3.240 and a standard deviation of 1.086, while we have 3.103 and 1.075, respectively.

Variable size has a mean of $32,777 millions with a standard deviation of $116,119 million, and it ranges from a minimum of $12 million to a maximum of $1,027,891 million. The huge standard deviation and range indicate a significant variation in firm size. Examination of the size distributions by different category indicates a common pattern: in each category, there are a few huge companies with the rest being small and middle sized. For example, out of 238 commercial banks, there are only 11 whose assets are over $100billions. In addition, insurance companies have the highest average size, followed by investment banks and commercial banks. Due to the highly skewed distribution of size, natural logarithm transformation is applied to this variable.

The governance variable, measured as the natural logarithm of median director dollar stockholding, has a mean of 13.626 and standard deviation of 1.24 and it ranges from a minimum of 9.284 to a maximum of 16.48. The distribution of this variable is similar across categories.

Table 3 presents the correlation among the key variables. First of all, as expected, all three risk measures are highly correlated with each other. Secondly, log of firm size is significantly correlated with risk as measured by log(z-score), volatility of return on asset and equity return, but not raw z-score. Interestingly, we found that more stable FIs are associated with lower market-to-book ratio, which is inconsistent with the finding in Demsetz, Saindenberg and Strahan (1996). In addition, governance variable is highly correlated with risk as measured by z-score and volatility of return on assets, but not the equity volatility. Lastly, CEO ownership is negatively correlated with all three risk measures.

4. Size and firm risk

4.1. Baseline regression

The premise of the paper is that size has a positive effect on firm's risk taking due to the moral hazard associated with "too-big-to-fail" policy. The primary measure risk taking is z-score with a higher z-score indicating more stability. We began by examining whether larger size is associated with greater risk as suggested by Boyd, Jagannathan and Kwak (2009). For brevity, we use label size in referring to the natural logarithm of size in the remainder of the paper. In Section 5, we extend the analysis by testing whether systematically important firms behave differently from smaller ones.

More formally, our baseline model is as follows:

$$z_i = \alpha_0 + \alpha_1 size_i + \alpha_2 mb_i + \alpha_3 dir_i + \alpha_4 own_i + \alpha_5 ibk_i + \alpha_6 ins_i + \varepsilon_i \quad (1)$$ [17]

where z_i is the z-score of firm *i*, $size_i$ is log of average total asset of firm *i*, mb_i is market-to-book asset ratio of firm *i*, computed as the market value of equity plus book value of debt divided by book value of total asset, which is then averaged over 1998-2008. dir_i is the governance variable, computed as the logarithm of median director dollar stockholding of firm *i* as of the last year in our sample period, own_i is the percentage of CEO ownership of firm *i* as of the last year in our sample period, ibk_i is a dummy variable, which equals one if firm *i* is an investment bank and 0 otherwise, ins_i is a dummy variable for insurance company, and defined analogously. ε_i is the error term and β_s (s=1…6) are vectors of coefficient estimates. Note that we only include leverage and profitability as controls in specifications when earnings volatility or equity volatility is used as dependent variable because z-score is a function of these two variables.

The discrepancies in the level of significance and signs on variable z-score and its log transformation ln(z-score) from correlation Table 3 raises concerns about the existence of outliers. In regression analysis, the presence of outliers can strongly distort the classical least

[17] Implicit in this specification is that we assume that relation between size and risk is linear and the effect of size on risk-taking is constant. Quadratic form on variable size has been used in some studies (i.e. Houston et al, 2010), however, we prefer the linear specification because a simple t-test in an unreported regression fails to reject the null hypothesis that the coefficient on variable size-squared equals zero when quadratic form is used.

squares estimator and lead to unreliable results. To investigate whether or not this is the case, we perform a series of standard diagnostics such as Cook's D influence statistic and studentized residuals. Results from these analyses indicate unusual points in our data. Figure 1 also presents the leverage-versus-squared residuals plot by running four separate OLS regressions as in Eq (1), with z-score, ln(z-score), earnings volatility, and equity volatility as respective dependent variables. The points which are far away from the mass of points indicate unusual observations. Figure 1 suggests that there exist outliers in our sample regardless which risk measures are used.

The simple diagnostic analysis precludes us from relying on the standard ordinary least squares (OLS) regression for inference. The common ways to deal with outliers are truncation or winsorization; we opt out these approaches for two reasons: first, we verify that those outliers are not data entry error; second, the total observations in our sample are rather limited. Instead, we rely on two other approaches to address this issue: median and robust regression[18].

Table 4 presents results of the regression analysis with both raw z-score and log z-score as dependent variables. They are estimated with three distinct methods: median, robust and OLS regressions. Since the lines between banks, investment banks and insurance companies are increasingly blurring[19], I also present the results without industry controls. For reasons mentioned previously, we focus on raw z-score. The overarching message from the regressions presented in Table 4 is the bigger size is generally associated with greater risk. Size enters negatively and it is significant at conventional levels. In regressions with log-transformation of z-

[18] Median regression, focusing on 0.5 quantile, is a special case of quantile regression. The difference between median and OLS regression is that, OLS minimizes squared error loss, while as median regression minimizes absolute error loss. Median regression is more robust to outliers than least-squares regression. See Cameron and Trivedi (2005) for details. This method is used by Aggarwal and Samwick (1999). It is the QREG command in Stata, version 10.0. Robust regression is used by Baker and Hall (2004). RREG uses Huber weight iterations followed by biweight iterations. It is the RREG command in Stata, version 10.0. See Hamilton (1991) for details.

[19] For example, Goldman Sachs and MetLife are now bank holding companies.

score, the signs on size are still expected but it is less significant. Comparing the results across estimation methods, we find that median regression and robust regression generate similar estimates, while the OLS estimate has much bigger magnitude. This is not surprising at all considering we have outliers in our sample. Our governance variable (*dir*) enters positively and is significant at 1% level in all regressions, meaning better governance as measured by median director dollar stockholding is associated with less risk-taking. This result provides strong evidence that our initial conjecture based on Diamond and Rajan (2009) is correct. However, it is in sharp contrast to Cheng, Hong and Scheinkman (2009), who use standard governance measures such as G-index and E-index and find governance has no effect on financial firms' risk-taking[20]. The economic size of coefficient on *dir* is consequential. A one standard deviation change in *dir* (1.24) is associated with a change in *z-score* of 3.68 (1.24*2.967), approximately 15% increase from its median (25.29).

Comparing the results from regressions with and without industry control reveals that the magnitude of the coefficient is smaller in regressions with industry controls, indicating that industry fixed effect might play an important role in shaping financial firm's risk-taking behavior. This point is confirmed by the finding that investment banks are significantly riskier than commercial banks: all the coefficients on investment bank dummy (*ibk*) are negative and significant at 1% level. This result is consistent with Kwast (1989) who documents that securities activities have higher standard deviation of returns than non-securities activities, and Allen and Jagtiani (1997) who find that securities firms on average have the highest market risk exposure among all financial institutions. Lastly, CEO ownership has a negative effect on z-score, but enters insignificantly.

[20] We find similar results in the unreported regressions when standard governance indices such as G-index, E-index, and GovScore are used as explanatory variables. Those results are available upon request.

As a robustness check, we use total revenue as our measure for the size of the firm. The results, with the log of total revenue replacing the log of total asset, are shown in Table 5. The coefficients on total revenue are very similar to those in Table 4, except that they are a little bigger in magnitude. Coefficients on other variables are qualitatively the same.

To summarize what we have found out so far in financial industry: consistent with H1, we have identified that size has a positive effect on risk-taking, although this effect became weaker when log transformation of z-score is being used. Better governance can significantly reduce risk-taking, which is consistent with H2; and lastly, investment banks are riskier than commercial banks, which support H3.

4.1.1. Endogeneity

The empirical corporate finance research has long been plagued by the problem of endogeneity, this research is no exception. Specifically, we are particularly concerned about the joint determination of risk-taking and firm size. Previous study has identified that banks are willing to pay large premium to make acquisitions that will make them sufficiently large and TBTF (Brewer III and Jagtiani, 2009). Therefore, although firms are more likely to pursue risk-taking activities when they become larger, it is also likely that high risk firms have the incentives to increase their sizes. To address this issue, we use identification strategy of instrumental variable (IV). In particular, we make use of variation in whether or not a firm incorporates in Delaware as an instrument for firm size. The idea for this instrument is that when a company decides to go public, the decision where to incorporate, while not random, should be exogenous to the unobservable factors that affect firms' risk-taking as induced by moral hazard of TBTF. The validity of an instrument critically hinges on whether the instrument satisfies this exclusion assumption.

Empirical legal and finance studies have investigated extensively why a firm would choose Delaware as its domicile. For example, Daines (2001) and Bhagat and Romano (2002) find there is a wealth effect associated with Delaware incorporation and that this effect is due to the fact that in Delaware, corporate law encourage takeover bids and facilitates the sale of public firms by reducing the cost of acquiring a Delaware firm. Apparently, this wealth effect should have nothing to do with a firm's risk-taking. Bebchuck and Cohen (2003) identify that favorable antitakeover protections are important for a state to attract out-of-state incorporation. From a different angle, Romano (1985) argues that Delaware's large store of precedent reduces transaction costs and uncertainty about legal liability. Lastly, Fisch (2000) note the peculiar role of the Delaware judiciary in corporate lawmaking, arguing that Delaware lawmaking offers Delaware corporations a variety of benefits, including flexibility, responsiveness, insulation from undue political influence, and transparency. While there are many factors that affect a firm's domicile decision, all of them seem centered around the legal environment of Delaware. In addition, other researchers have argued that a firm's choice of domicile is unimportant and trivial (Black, 1990). We thus conclude that the dummy for Delaware incorporation is a valid instrument.

Table 6, Panel A compares Delaware firms with non-Delaware firms in terms of firm characteristics, revealing that Delaware firms tend to have a larger market-to-book asset ratio, are more likely to be investment banks, and less leveraged. Panel B of the Table compares size and risk-taking for Delaware and non-Delaware firms. It shows that Delaware firms are significant larger and riskier. Figure 2 shows the distributions of firm size, revealing a systematic shift in the firm size from non-Delaware firm to Delaware firm.

The IV approach involves estimating a two-stage model of the following form:

$$z_i = \alpha_0 + \alpha_1 size_i + \alpha_2 mb_i + \alpha_3 dir_i + \alpha_4 own_i + \alpha_5 ibk_i + \alpha_6 ins_i + \varepsilon_i \quad (2)$$

$$size_i = \beta_0 + \beta_1 de_i + \beta_2 mb_i + \beta_3 dir_i + \beta_4 own_i + \beta_5 ibk_i + \beta_6 ins_i + \upsilon_i \quad (3)$$

where de_i is a dummy variable which equals one if firm *i* is Delaware incorporated, and the rest of the variables are defined as per Eq. (1)

Identification of the IV model requires a strong correlation between Delaware dummy variable and firm size. Results from the first-stage regression with and without the full set of controls are presented in Table 6, Part A. For the specification with full set of controls (col. 3), the Delaware firms are on average significantly larger than non-Delaware firms. This result is consistent with Bebchuk and Cohen (2004) who identify a similar pattern based on a universe of all publicly traded firms in the Compustat database at the end of 1999 (see table 8, page 403). The standard error is 0.25 and the partial *F*-statistic on the instrument is 18.78, which satisfies the weak instrument test as discussed in Bound et al (1995) and Staiger and Stock (1997). Results from IV estimates for risk-taking, as measured by z-score, logarithm of z-score, standard deviation of return on asset and annual stock return, are reported in Table 6, Part B. The results on z-score are consistent with the finding in Table 4 although the magnitude of size effect is larger for IV estimates. This fact suggests that OLS estimate underestimates the true effect of firm size on risk-taking. The results on Column 3 and 4 reveal that size doesn't have a significant impact on volatility of profitability and stock return. This result is consistent with Demsetz and Strahan (1997), who do not find evidence that size of bank holding companies are negatively correlated with stock return variance. The findings on governance variable and investment banks are consistent with previous finds as well.

4.2. Decomposition of z-score

The relation between z-score and its three components, ROA, CAR, and σ(ROA), is straightforward: all else being equal, higher level of ROA and higher capital asset ratios (CAR) translate into higher z-scores, while a larger standard deviation of ROA translates into lower z-scores. Thus, when we find a positive relation between size and risk-taking, it might attribute to a lower ROA, lower capital ratio, and/or a higher standard deviation. Therefore, it is possible that size may not necessarily increase the risk of firm assets, but rather the drop in z-score may instead be attributed to a decline in the average bank capital ratio or return on asset. To further explore how the various components of the z-score move in response to an increase in firm size, we run regressions treating each of these z-score components as a separate dependent variable. The empirical results are reported in Table 8.

We see that an increase in size is associated with a decrease in capital asset ratio at 1% significance level across all three estimation methods, consistent with Schmid and Walter (2009). As for the economic effect, on average, a 10 percent increase in size would translate into a 0.3 percent reduction in capital asset ratio, holding other variables constant. Size does not have a significant impact on return on asset or decrease earnings volatility. These results indicate that the lower z-score is primarily driven by a reduction in capital, and size related economy of scale, if any, does not exist in the financial industry. Indeed, a large empirical literature on economies of scale of financial firms has produced inconclusive results. Our finding is also consistent with Geanakoplos (2010) who argues that extreme high leverage in boom times has a huge impact on the price of assets, contributing to economic bubbles and busts. He suggests that the Federal Reserve should manage system wide leverage, curtailing leverage in ebullient times, and propping up leverage in anxious times. This finding has direct policy implications: instead of setting a size threshold, strengthening capital requirements might be a more direct way to solve the excessive risk-taking problem as pronounced in financial institutions. As Judah S. Kraushaar, managing director of Roaring Brook Capital, L.P., pointed out, “attacking excessive leverage in the banking system may go a long way toward dampening the boom-bust cycle that has become alarmingly intense in recent decades”[21]. As a suggestion, for example, regulators can set capital requirements in such a way that they are proportionate in size[22]. The common concern for raising capital is that equity is “expensive” and capital adversely affects bank value. However, recent study on bank capital challenges this view and provides theoretical and empirical evidence that total bank value and the bank’s equity capital are positively correlated in the cross-section (Mehran and Thakor, 2010). We agree that such solution may not be optimal[23], but it has the advantage of tackling the problem from the root: correcting the distortion in risk-taking incentives. This becomes even more relevant when policy makers are faced with the thorny problem of correctly categorizing TBTF bank along with other obstacles mentioned earlier.

Beyond the revealing finding regarding how exactly size affects z-score, note that the results from the specification on capital-asset ratio (CAR) in Table 8 are consistent with several stylized facts known from capital structure literature[24]. For instance, market-to-book asset ratio is positively correlated with CAR, return on asset (ROA) is negatively correlated with CAR, and

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[21] “Banks Need Clear Capital Rules”, The Wall Street Journal, January 22, 2010.

[22] This point is similar to the recommendation in The Squam Lake Report, where it argues that, if everything else is the same, large banks should face higher capital requirements than small banks. This idea has also been proposed by Congressional Oversight Panel as one way to limit excessive risk-taking (see, Congressional Oversight Panel, 2009, p. 26). “Of Banks and Bonus”, New York Times, July 27, 2009, have similar arguments as well.

[23] Hellmann, Murdock, and Stiglitz (2000) argue that it is impossible to implement any Pareto-efficient outcome using just capital requirements as the tool of prudential regulation. They propose a combination of deposit rate controls and capital requirements. However, their arguments only apply to deposit-taking financial firms. Marshall and Prescott (2001) have similar arguments.

[24] See Frank and Goyal (2008) for a survey of literature on capital structure.

the constant term, which can be thought of as tangible asset[25], is negatively correlated with CAR. These results are consistent with the trade-off theory of capital structure.

The control variables also yield some interesting and consistent findings. Corporate governance (*dir*) is positively associated with ROA and negatively associated with earning volatility, but has no effect on capital asset ratio. These results suggest better governance enhances firm performance, consistent with Bhagat and Bolton (2008) where they note a significant and positive relation between this variable and contemporaneous and next year's operating performance. These findings help us to understand more about the effect of variable *dir* on risk-taking as shown in Table 4 and Table 5: the risk-reducing mechanism of corporate governance is mainly through an increase in ROA and a reduction in earnings volatility. The market-to-book asset ratio enters positively in all regressions in Table 8, and is significant at 1% level.

The last panel in Table 8 reports regression results using equity volatility as dependent variables. In contrast to our IV results in Table 7, we find that size enters negatively and significant in the robust and OLS regressions. This discrepancy suggests that there might be an endogeneity issue in the baseline specification. Overall, these findings indicate that the risk-reducing potential of diversification at large firms is offset by their lower capital ratios. Findings on other controls are consistent: less profitable firms and highly levered firms are associated with higher equity volatility, as expected.

5. Do financial firms of different size behave differently?

5.1. Difference-in-differences method

[25] Financial firms usually have a relatively small portion of tangible assets, which can be thought of as constant in the specification.

After having established that on average, larger firms are riskier than small firms, a natural question to ask is: do firms of different size cohorts behave differently? Researchers have shown that the status of TBTF itself has values. For instance, using an event study methodology, O'hara and Shaw (1990) find a positive wealth effect accruing to TBTF banks. Brewer III and Jagtiani (2009) document that financial firms were willing to pay at least $14 billion in added premiums to mergers which will make them obtain the status of TBTF. To address the above question, we test whether the marginal effect of firm size on risk-taking is different between firms who may be considered TBTF and firms who are not.

Specifically, we employ the difference-in-differences type methodology. This method suits our needs well because it gives us a slope difference estimate of size on risk-taking with a standard error for two separate regressions: one is for the TBTF group and the other for the non-TBTF group.

To be more concrete, I estimate the following equation:

$$z_i = \lambda_0 + \lambda_1 big_i + \lambda_2 size_i + \lambda_3 big_i * size_i + \lambda_4 mb_i + \lambda_5 dir_i + \lambda_6 own_i + \lambda_7 ibk_i + \lambda_8 ins_i + \xi_i \quad (4)$$

where big_i is a dummy variable indicating whether firm *i* is TBTF, and the rest of the variables are defined as per Eq. (1). To correctly identify TBTF is not trivial task. The reason is that, although we observe government rescues *ex post*, but no firm has ever been identified officially as TBTF *ex ante*. To address this issue, we rely on theory based on Goodhart and Huang (2005) who show that central bank would only rescue banks which are above a threshold size[26]. We define firms with total asset over $10 billion as TBTF[27].

5.2. Results on risk shift

Results from the differences-in-differences are shown in Table 9 with raw z-score, log of z-score and equity volatility as respective dependent variables. Again, results with three estimation methods are presented. The variable of interest is the interaction term (*big_size*). The sign on *big_size* is negative, meaning an increase in size is associated with more decrease in *z-score* (and *ln(z-score)*) for big firms than small firms, but it is not significant at conventional level. The coefficient on *big* seems contradictory to our previous finding that larger firms are associated with higher risk-taking. Our explanation is that, in the difference-in-difference model, the coefficient on *big* tests whether there is difference in risk-taking between big and small firms when firm size equal zero, which does not bear any meaningful interpretation. Consistent with the findings in Table 4, governance variable (*dir*) has a significant effect in reducing firm risk-taking; investment banks are riskier than commercial banks.

Regression results with equity volatility as dependent variable from the last panel in Table 9 are interesting. The coefficient on *logat* measures the effect of size on risk-taking for small firms only; they are negative and significant across all three estimation methods. It is similar to what we find in Table 8, but the interpretation is quite different: size-related diversification only exists for firms below certain threshold size; once firms pass this threshold, the diversification effect either disappears or attenuates significantly. Finding on *roa* and *leverage* are consistent with Table 8 as well.

[26] As shown in Goodhart and Huang (2005), in addition to size, central bank's ultimate rescue decision also depends on the tradeoff between contagion and moral hazard effects.
[27] We tried $50 billion, $100 billion cutoffs, the results are qualitatively unchanged.

Base on finding from Table 9, we conclude that there is no significant evidence that big firms behave differently than small firms, which is inconsistent with H4.

6. Policy Implications

Recent financial crisis has eroded the economic net worth of many financial institutions. The consensus has been that TBTF financial firms have taken too much risk prior to the crisis. Regarding the remedies, many opinions have been expressed such as capping the size of firms. However, given the difficulty of correctly identifying TBTF financial institutions, serious concerns have been raised with this simple size constraint. In this paper, we went one step further to find out that, although we do observe a positive association between firm size and risk-taking, what is really going on behind the scene is that these firms have taken too much leverage. This finding has important implications for policy makers: regulations designed to rein risk-taking of financial firms should focus more on capital requirements[28], this suggestion is also reinforced by the fact that leverage is positively associated with equity volatility. Our second finding that corporate governance, measured as median director dollar stock ownership, can significantly influence firm's risk-taking also bears its own merits. This measure is rather simple and intuitive comparing with standard governance indices, thus it is relatively easier for corporate boards to implement when making risk management policies. Our last finding that investment banks are consistently riskier than commercial banks reminds us the watershed events of the 1930s when the so-called Glass-Steagall Act was passed to prohibit firms with a commercial banking charter from conducting security business. It provides justification for the functional separation of investment banking from universal banking.

[28] To be clear, what is the optimal capital requirement policy is a question deserving future research and beyond the scope of this paper. Kashyap, Rajan and Stein (2008) have a discussion about this question.

Appendix A

Variable definitions and data sources.

Variable	Definition	Original sources
Risk measures		
z-score	equals (ROA+CAR/σ(ROA), where ROA=π/A is return on assets and CAR =E/A is capital-asset ratio, both averaged over 2000-2007. σ(ROA) is the standard deviation of ROA over 1998-2008. Higher Z implies more stability	Compustat
ln(z-score)	equals natural logarithm of z-score	
ROA	Return on assets, averaged over 1998-2008. Higher value implies more stability	Compustat
CAR	Capital asset ratio, averaged over 1998-2008. Higher value implies more stability	Compustat
σ(ROA)	Equals standard deviation of ROA, computed over 1998-2008	Compustat
σ(RET)	equals standard deviation of RET, computed over 1998-2008. RET is annual stock return from 1998 to 2008	CRSP
Controls		
size	equals the natural logarithm of the average total asset over 1998-2008	Compustat
ln(rev)	equals the natural logarithm of the average total revenue over 1998-2008	Compustat
mb	equals the market-to-book value, averaged over 1998-2008	Compustat
dir	equals the median director dollar stockholding as of the last year of the sample period	RiskMetrics and Proxy statement
own	equals the percentage of CEO stock ownership, as of the last year of the sample period	RiskMetrics and Proxy statement
leverage	equal total liability divided by total asset, averaged over 1998-2008	Compustat
ibk	a dummy variable that equals one if investment bank, zero otherwise	Compustat
ins	a dummy variable that equals one if insurance company, zero otherwise	Compustat
big	equals 1 if total asset is over $10billions, 0 otherwise	

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Figure 1

Plot of leverage-versus-squared residuals.

This figure is generated by running four separate OLS regressions, with z-score, log of z-score, log of earnings volatility, and log of equity volatility as respective dependent variables (Eq.1). Leverage on the y-axis measures how far an independent variable deviates from its mean. Normalized residual square on x-axis indicates outliers. Variable definitions are in Appendix A.

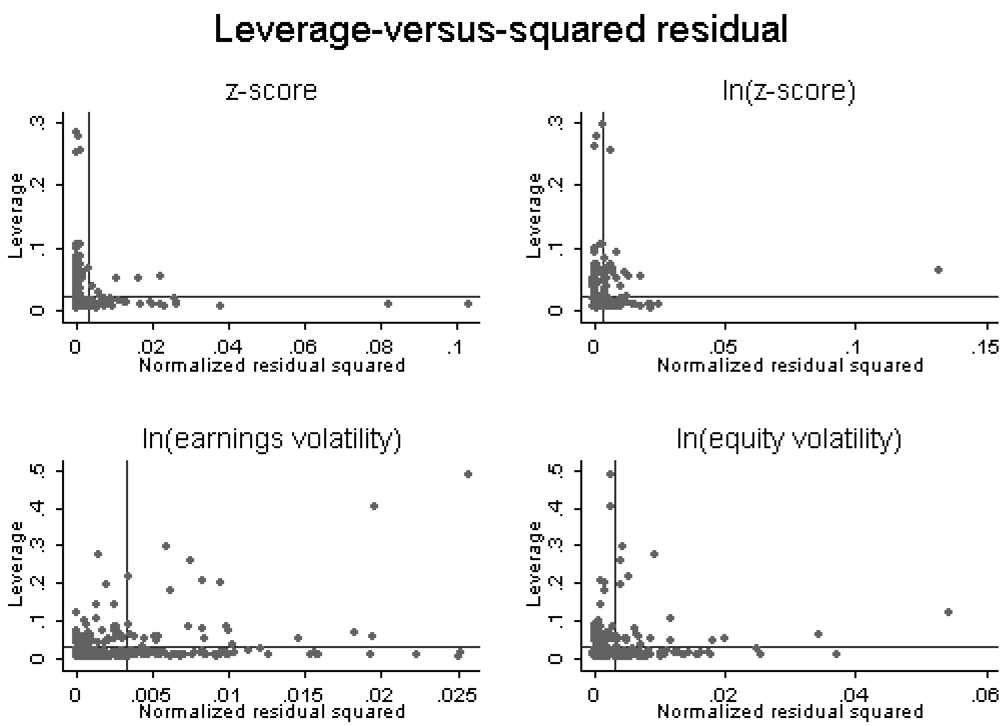

Figure 2
Empirical distribution of firm size by non-Delaware firms and Delaware firms.

Firm size is the logarithm transformation of the average size from 1998-2008 for each firm. The sample includes commercial banks, investment banks and insurance companies. Epanechnikov kernel.

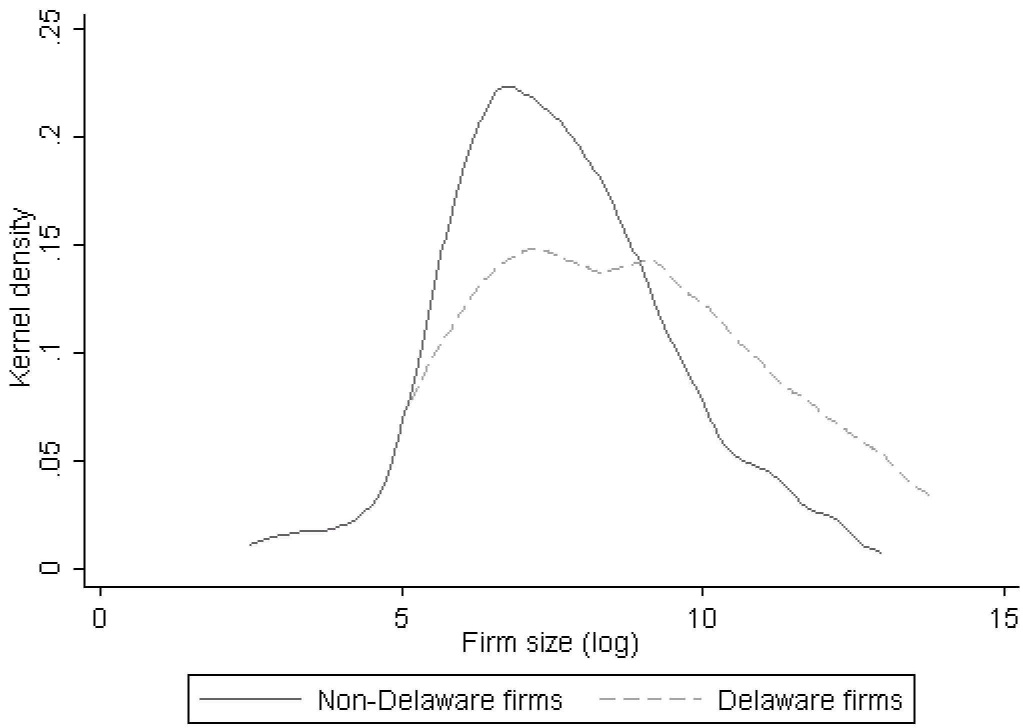

Table 1

Comparison of this paper with previous studies that are related to risk-taking of financial institutions.

Study	Sample period &size	Data source & screens	Dependent Variable (risk)	Firm Size	Sign	Variable of interest	Other independent variables
Sauders, Strock and Travlos (1990)	1978-1985 38	Call Report Bank holding company only	Standard deviation of dairly stock return	Total asset	+	Insider ownership	Insider ownership Capital asset ratio Operating leverage
Boyd and Runkle (1993)	1971-1990 122	Annual COMPUSTAT data Bank holding company only Total asset >$1 billion Require 5 consecutive years	z-score Standard deviation of ROA Equity/asset	Log of total asset	-	Size	
Demsetz and Strahan (1997)	1980-1993 134	Bank holding companies only Y-9C Report & CRSP Trading weekds >30	Firm-specific risk (σ(ε))	Log of total asset	-***	Size	Capital asset ratio squared Loan characteristics
De Nicolo (2000)	1988-1998 419	Worldscope Bank holding company only Require at least 3 year data	z-score Volatility of ROA Equity asset ratio ROA	Log of total asset	-**	Size	Asset growth rate
Boyd, De Nicolo and Al Jalal (2006)	June, 2003 2500	Small banks Operate only in rural non-Metropolitan Statistical Areas	z-score Equity asset ratio	Log of total asset	-***	Bank competition	Bank Competition Country controls
Stiroh (2006)	1997-2004 400	Y-9C Bank holding companies only	Standard deviation of weekly stock return	Log of asset	-***		Log of equity asset ratio Loan & income controls
Laeven and Levine (2009)	1996-2001 270	Bankscope&Bankers Almanac 10 largest public banks in each country	z-score	Log of total asset	-*	Cash flow right	Cash flow right Country controls
Houston et al (2010)	2000-2007 2400	BankScope Banks only Cross-country study	z-score ROA Capital asset ratio Volatility of ROA	Log of total asset	+***	Creditor right	Log of total asset square Credit rights Country controls
This Paper	1998-2008 302	Compustat & Proxy statement Commercial bank, investmnet bank and insurance	z-score Volatility of ROA Volatility of stock return	Log of total asset Log of total avenue	-**	Size Governance	Market to book Corporate governance CEO ownership Industry controls

Note: *, **, and *** indicate significance of 10%, 5%, and 1%, respectively in the original papers.

Table 2

Summary statistics.

This table reports summary statistics of the main regression variables for all financial institutions (Panel A), commercial banks (Panel B), investment banks (Panel C) and life insurance (Panel D). SIC codes 6020, 6211 and 6311 are used to define commercial banks, investment banks and life insurance, respectively. Sample consists of 258 commercial banks, 38 investment banks and 26 life insurance companies. Statistics based on average annual data over 1998-2008, unless otherwise indicated. z-score is firm's return on assets plus the capital asset ratio divided by the standard deviation of asset return over period 1998-2008. σ(ROA) is the volatility of the firm's return on assets over the period 1998-2008. Equity volatility is standard deviation of annual stock return over 1998-2008. Size is the book total asset (millions). Market-to-book is calculated as market value of equity plus book value of debt divided by book total asset. ROA is the return on asset. Leverage is the debt asset ratio. Director ownership ($) is natural logarithm of median director dollar stockholding as of the last year in our sample period. CEO ownership (%) is percentage of CEO stock ownership as of the last year in our sample period.

Panel A: all financial institutions

variable	mean	median	Standard Deviation	min	max	N
z-score	34.075	25.292	30.824	-0.289	203.143	302
ln(z-score)	3.103	3.238	1.075	-4.094	5.279	300
σ(ROA)	0.021	0.004	0.070	0.000	0.605	302
Equity volatility	0.357	0.300	0.248	0.075	2.302	302
Size	32,777	2,240	116,119	12	1,027,891	302
ln(size)	7.982	7.714	2.109	2.496	13.843	302
Market-to-book	1.158	1.073	0.426	0.761	4.756	302
ROA	0.007	0.009	0.054	-0.407	0.562	302
Leverage	0.870	0.908	0.138	0.136	0.972	302
Director ownership($)	13.626	13.700	1.240	9.284	16.480	300
CEO ownership (%)	0.043	0.011	0.105	0.000	0.889	302

Panel B: commercial banks

variable	mean	median	Standard Deviation	min	max	N
z-score	38.300	30.699	32.120	1.996	203.143	238
ln(z-score)	3.277	3.424	0.936	0.691	5.279	238
σ(ROA)	0.006	0.003	0.009	0.000	0.071	238
Equity volatility	0.310	0.288	0.136	0.075	0.919	238
Size	24,352	2,112	104,774	79	1,027,891	238
ln(size)	7.924	7.655	1.834	4.367	13.843	238
Market-to-book	1.081	1.073	0.064	0.983	1.477	238
ROA	0.009	0.010	0.006	-0.026	0.036	238
Leverage	0.908	0.910	0.023	0.775	0.947	238
Director ownership($)	13.740	13.742	1.157	9.284	16.480	238
CEO ownership (%)	0.029	0.011	0.059	0.000	0.535	238

Table 2. (*continued*)
Panel C: investment banks

variable	mean	median	Standard Deviation	min	max	N
z-score	10.211	8.347	9.035	-0.289	39.662	38
ln(z-score)	1.896	2.154	1.360	-4.094	3.680	36
σ(ROA)	0.123	0.056	0.163	0.001	0.605	38
Equity volatility	0.674	0.464	0.503	0.227	2.302	38
Size	52,361	689	146,691	12	656,829	38
ln(size)	7.208	6.535	2.953	2.496	13.395	38
Market-to-book	1.727	1.263	1.032	0.761	4.756	38
ROA	-0.006	0.006	0.153	-0.407	0.562	38
leverage	0.625	0.656	0.280	0.136	0.967	38
Director ownership ($)	13.228	13.348	1.338	10.285	16.020	38
CEO ownership (%)	0.142	0.031	0.230	0.001	0.889	38

Panel D: life insurance

variable	mean	median	Standard Deviation	min	max	N
z-score	30.284	24.707	22.080	2.945	96.981	26
ln(z-score)	3.181	3.207	0.728	1.080	4.575	26
σ(ROA)	0.007	0.004	0.008	0.001	0.039	26
Equity volatility	0.316	0.305	0.113	0.113	0.640	26
Size	81,275	15,824	150,747	78	641,511	26
ln(size)	9.647	9.663	2.222	4.357	13.372	26
Market-to-book	1.031	1.015	0.091	0.875	1.322	26
ROA	0.008	0.006	0.006	-0.002	0.030	26
Leverage	0.880	0.895	0.069	0.736	0.972	26
Director ownership($)	13.118	13.327	1.629	9.559	16.308	24
CEO ownership (%)	0.025	0.005	0.060	0.000	0.259	26

Table 3

Correlation matrix of main regression variables.

This table reports the correlations between the main regression variables. Sample consists of 302 financial institutions. Statistics based on averages of annual data over the period 1998-2008, unless otherwise indicated. z-score =(ROA+CAR)/σ(ROA). σ(ROA) is the volatility of the firm's return on assets over the period 1998-2008. Equity volatility is standard deviation of annual stock return over 1998-2008. Size is the total asset (in $ millions). ln(rev) is log of total revenue (in $ millions). Market-to-book is calculated as market value of equity plus book value of debt divided by book total asset. ROA is the return on asset. Leverage is the debt asset ratio. Director ownership ($) is natural logarithm of median director dollar stockholding as of the last year in our sample period. CEO ownership (%) is percentage of CEO stock ownership as of the last year in our sample period. p-values denoting the significance level of each correlation coefficients are in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	z_score	ln(z-score)	σ(ROA)	equity volatility	size	ln(size)	ln(rev)	Market-to-book	ROA	leverage	director ownership
ln(z-score)	0.807***										
	0.000										
σ(ROA)	-0.271***	-0.597***									
	0.000	0.000									
equity	-0.329***	-0.531***	0.554***								
volatility	0.000	0.000	0.000								
size	-0.098*	-0.034	-0.059	-0.038							
	0.090	0.555	0.309	0.517							
ln(size)	-0.053	0.106*	-0.309***	-0.256***	0.588***						
	0.358	0.067	0.000	0.000	0.000						
ln(rev)	-0.141**	-0.018	-0.111*	-0.093	0.590***	0.950***					
	0.014	0.760	0.055	0.107	0.000	0.000					
market-to-	-0.168***	-0.250***	0.564***	0.349***	-0.048	-0.159***	0.024				
book	0.003	0.000	0.000	0.000	0.411	0.006	0.681				
ROA	0.083	0.236***	-0.278***	-0.370***	0.010	0.148**	0.100*	0.275***			
	0.149	0.000	0.000	0.000	0.857	0.010	0.084	0.000			
leverage	0.207***	0.370***	-0.545***	-0.305***	0.108*	0.369***	0.141**	-0.573***	0.036		
	0.000	0.000	0.000	0.000	0.060	0.000	0.015	0.000	0.534		
director	0.181***	0.215***	-0.116**	-0.085	0.132**	0.320***	0.280***	0.031	0.150***	0.214***	
ownership	0.002	0.000	0.044	0.142	0.022	0.000	0.000	0.590	0.009	0.000	
CEO	-0.144**	-0.221***	0.200***	0.295***	-0.095*	-0.302***	-0.170***	0.334***	-0.073	-0.525***	-0.159***
ownership	0.012	0.000	0.001	0.000	0.099	0.000	0.003	0.000	0.208	0.000	0.006

Table 4

Firm size (total asset) and risk taking

The dependent variable is raw z-score for the first 6 regressions and logarithm of z-score for the second 6, which are further separated by whether or not they have industry controls. Results from three estimation methods are presented: Median means median quantile regression (QREG in STATA), Robust means robust regression or iteratively reweighted least squares (RREG in STATA), OLS regressions are based on heteroskedasticity-consistent standard errors (White 1980). Sample consists of 300 financial firms. Regression variables are computed as the averages over 1998-2008, unless otherwise noted. z-score =(ROA+CAR)/σ(ROA), where ROA=π/A is return on assets and CAR=E/A is capital-asset ratio, both averaged over 1998-2008. σ(ROA) is the standard deviation of ROA over 1998-2008. Higher z-score implies more stability. *Ln(z-score)* is natural logarithm of z-score. *ln(at)* is the logarithm of total asset. *mb* is the average market-to-book asset ratio. *dir* is the logarithm of median director dollar stockholding as of the last year in our sample period. *own* is CEO stock percentage ownership as of the last year in our sample period. *ibk* is dummy for investment banks, and ins is dummy for insurance companies.*,**, and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	z-score						ln(z-score)					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Median	Robust	OLS	Median	Robust	OLS	Median	Robust	OLS	Median	Robust	OLS
Ln(at)	-1.735*	-1.586**	-2.687***	-1.436**	-1.430*	-2.551***	-0.0681**	-0.0428	-0.0117	-0.0644*	-0.0337	2.97e-05
	(0.999)	(0.731)	(0.839)	(0.651)	(0.748)	(0.884)	(0.0323)	(0.0290)	(0.0348)	(0.0341)	(0.0296)	(0.0375)
mb	-9.309**	-10.22***	-12.19***	-3.058	-3.577	-4.285**	-0.654***	-0.608***	-0.563***	-0.342**	-0.298**	-0.191
	(4.129)	(3.494)	(2.459)	(3.233)	(3.794)	(2.033)	(0.151)	(0.140)	(0.152)	(0.167)	(0.148)	(0.166)
dir	4.821***	4.839***	5.662***	2.967***	4.091***	4.932***	0.160***	0.206***	0.184***	0.152***	0.182***	0.148***
	(1.645)	(1.198)	(1.695)	(1.065)	(1.204)	(1.735)	(0.0527)	(0.0470)	(0.0533)	(0.0545)	(0.0469)	(0.0542)
own	-13.95	-22.28	-31.65**	2.364	-10.38	-17.24*	-0.499	-0.607	-1.204	0.110	0.0142	-0.408
	(19.44)	(14.70)	(13.83)	(11.22)	(14.60)	(10.34)	(0.635)	(0.581)	(0.910)	(0.583)	(0.576)	(0.731)
ibk				-19.56***	-18.99***	-22.67***				-0.951***	-0.958***	-1.141***
				(4.231)	(4.913)	(3.238)				(0.219)	(0.194)	(0.253)
ins				-2.457	-0.873	-0.759				-0.0356	0.0236	-0.0446
				(4.574)	(5.334)	(5.048)				(0.238)	(0.208)	(0.172)
Constant	-14.81	-10.31	-6.114	4.033	-7.076	-4.117	2.362***	1.412**	1.385**	2.174***	1.392**	1.458**
	(21.72)	(15.95)	(21.38)	(13.77)	(15.63)	(21.20)	(0.703)	(0.627)	(0.692)	(0.706)	(0.610)	(0.650)
Obs	300	300	300	300	300	300	298	298	298	298	298	298
R^2		0.093	0.094		0.137	0.135		0.128	0.124		0.201	0.207

Table 5

Firm size (total revenue) and risk taking

The dependent variable is raw z-score for the first 6 regressions and logarithm of z-score for the second 6, which are further separated by whether or not they have industry controls. Results from three estimation methods are presented: Median means median quantile regression (QREG in STATA), Robust means robust regression or iteratively reweighted least squares (RREG in STATA), OLS regressions are based on heteroskedasticity-consistent standard errors (White 1980). Sample consists of 300 financial firms. Regression variables are computed as the averages over 1998-2008, unless otherwise noted. z-score =(ROA+CAR)/σ(ROA), where ROA=π/A is return on assets and CAR=E/A is capital-asset ratio, both averaged over 1998-2008. σ(ROA) is the standard deviation of ROA over 1998-2008. Higher z-score implies more stability. Ln(z-score) is natural logarithm of z-score. *ln(rev)* is the logarithm of total revenue. *mb* is the average market-to-book asset ratio. *dir* is the logarithm of median director dollar stockholding as of the last year in our sample period. *own* is CEO stock percentage ownership as of the last year in our sample period. *ibk* is dummy for investment banks, and *ins* is dummy for insurance companies.*,**, and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	z-score						ln(z-score)					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Median	Robust	OLS	Median	Robust	OLS	Median	Robust	OLS	Median	Robust	OLS
Ln(rev)	-2.080**	-2.167***	-3.298***	-1.490**	-1.684**	-2.796***	-0.0722**	-0.0635**	-0.0489*	-0.0653	-0.0400	-0.0158
	(0.956)	(0.717)	(0.829)	(0.704)	(0.770)	(0.919)	(0.0315)	(0.0283)	(0.0274)	(0.0410)	(0.0301)	(0.0327)
mb	-8.565**	-8.836**	-9.903***	-2.638	-3.061	-3.312*	-0.584***	-0.568***	-0.540***	-0.203	-0.284*	-0.192
	(3.995)	(3.452)	(2.221)	(3.414)	(3.783)	(1.986)	(0.150)	(0.139)	(0.155)	(0.202)	(0.148)	(0.164)
dir	4.801***	4.995***	5.726***	3.156***	4.193***	4.988***	0.173***	0.213***	0.199***	0.149**	0.185***	0.157***
	(1.591)	(1.172)	(1.649)	(1.117)	(1.203)	(1.722)	(0.0520)	(0.0463)	(0.0515)	(0.0635)	(0.0467)	(0.0521)
own	-1.930	-21.26	-29.14**	2.321	-9.947	-15.74	-0.0171	-0.609	-1.298	0.0804	0.0202	-0.470
	(18.59)	(14.34)	(12.71)	(11.82)	(14.50)	(9.972)	(0.618)	(0.567)	(0.959)	(0.741)	(0.568)	(0.761)
ibk				-17.14***	-17.09***	-19.35***				-0.979***	-0.915***	-1.114***
				(4.552)	(5.061)	(3.160)				(0.267)	(0.200)	(0.263)
ins				-2.123	0.100	0.688				-0.0314	0.0483	-0.00383
				(5.005)	(5.445)	(5.176)				(0.287)	(0.211)	(0.166)
Constant	-18.33	-14.73	-12.89	-2.565	-11.34	-11.45	1.938***	1.288**	1.345*	1.913**	1.284**	1.430**
	(21.16)	(15.73)	(21.24)	(14.61)	(15.71)	(21.50)	(0.696)	(0.621)	(0.687)	(0.831)	(0.611)	(0.660)
Obs	300	300	300	300	300	300	298	298	298	298	298	298
R^2		0.107	0.109		0.141	0.138		0.137	0.131		0.203	0.208

Table 6

Comparison of Delaware and non-Delaware firms

This table shows the mean difference in firm characteristics, risk-taking and firm size between Non-Delaware and Delaware firms. Statistics based on average annual data over 1998-2008, unless otherwise indicated. z-score is firm's return on assets plus the capital asset ratio divided by the standard deviation of asset return over period 1998-2008. σ(ROA) is the volatility of the firm's return on assets over the period 1998-2008. σ(RET) is standard deviation of annual stock return over 1998-2008. Market-to-book is calculated as market value of equity plus book value of debt divided by book total asset. ROA is the return on asset. Leverage is the debt asset ratio. Director ownership ($) is natural logarithm of median director dollar stockholding as of the last year in our sample period. CEO ownership (%) is percentage of CEO stock ownership as of the last year in our sample period.

Panel A

	Firm characteristics						
Variables	market to book ratio	Director Ownership	CEO ownership	Investment bank	Insurance company	ROA	Leverage
non-Delaware	1.110	13.611	0.041	0.058	0.068	0.004	0.882
Delaware	1.262	13.657	0.048	0.271	0.125	0.014	0.843
Difference	0.152	0.047	0.007	0.213	0.057	0.010	-0.039
t statistics	2.21	0.30	0.55	4.40	1.49	1.20	-1.990

Panel B

	Size measures			Risk measures			
Variables	Log(total asset)	Log(total revenue)	Log(mkt value)	z-score	log(z-score)	σ(ROA)	σ(RET)
non-Delaware	7.589	5.086	5.812	38.397	3.260	0.017	0.337
Delaware	8.827	6.556	7.153	24.802	2.770	0.030	0.398
Difference	1.238	1.470	1.341	-13.594	-0.489	0.013	0.061
t statistics	4.59	5.74	5.15	-3.85	-3.89	1.45	2.05

Table 7

Two-Stage Least Square (2SLS) IV regression of firm size on risk-taking

Part A presents the first-stage regressions of firm size on the instrumental variable (Delaware), and other pre-determined controls included in the second stage regressions of risk-taking on firm size. These controls include market-to-book asset ratio, median director dollar stockholding, CEO stock ownership, dummy for investment bank, dummy for insurance company, return on asset, and leverage. Part B reports the results from the second-stage regressions of risk-taking on firm size and control variables, in which firm size, instrumented by Delaware, is treated as an endogenous variable. Sample consists of 300 financial firms. Regression variables are computed as the averages over 1998-2008, unless otherwise noted. *Delaware* is dummy, which equals 1 for firms incorporated in Delaware. Z-score = (ROA+CAR)/σ(ROA), where ROA=π/A is return on assets and CAR=E/A is capital-asset ratio, both averaged over 1998-2008. σ(ROA) is the standard deviation of ROA over 1998-2008. Higher z-score implies more stability. *Ln(z-score)* is natural logarithm of *z-score*. *σ(RET)* is the standard deviation of annual stock return over 1998-2008. *ln(at)* is the logarithm of total asset. *mb* is the market-to-book asset ratio. *dir* is the logarithm of median director dollar stockholding as of the last year in our sample period. *own* is CEO stock percentage ownership as of the last year in our sample period. *ibk* is dummy for investment banks, and *ins* is dummy for insurance companies. *Leverage* is debt/asset ratio. *F*-statistic is the partial *F*-statistic on the instrument. DWH test is Durbin-Wu-Hausman test of endogeneity*, **, and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Part A: First-Stage Regression: Firm Size (log)			
	(1)	(2)	(3)
Delaware	1.238***	1.226***	1.094***
	(0.270)	(0.258)	(0.252)
mb		-0.571**	-0.289
		(0.270)	(0.377)
dir		0.531***	0.445***
		(0.078)	(0.073)
own		-4.116***	-2.086*
		(1.185)	(1.183)
ibk		-0.150	1.022**
		(0.476)	(0.494)
ins		1.933***	2.033***
		(0.370)	(0.345)
roa			3.709
			(3.110)
leverage			5.371***
			(1.060)
Constant	7.589***	1.061	-2.993**
	(0.132)	(1.037)	(1.291)
Partial R^2	-	0.088	0.076
F-statistic	21.04	22.63	18.78
Observations	302	300	300
R-squared	0.075	0.326	0.384

Table 7 (*continued*)

	Part B: Second-Stage Regression: Firm Size on Risk-Taking			
	(1)	(2)	(3)	(4)
VARIABLES	z-score	ln(z-score)	σ(ROA)	σ(RET)
ln(at)	-7.259**	-0.205	-0.006	0.0002
	(3.204)	(0.130)	(0.005)	(0.025)
mb	-6.770**	-0.278	0.0862**	0.222***
	(3.343)	(0.215)	(0.034)	(0.081)
dir	7.573***	0.260***	0.001	-0.003
	(2.292)	(0.093)	(0.003)	(0.015)
own	-38.74*	-1.431	-0.132**	0.315
	(19.91)	(0.881)	(0.063)	(0.247)
ibk	-20.66***	-1.015***	0.0491***	0.285***
	(5.143)	(0.329)	(0.018)	(0.094)
ins	9.915	0.420	0.014	0.028
	(8.957)	(0.329)	(0.012)	(0.063)
roa			-0.498*	-2.004***
			(0.279)	(0.689)
leverage			-0.057	0.463*
			(0.075)	(0.263)
Constant	0.222	1.668**	0.011	-0.302
	(22.92)	(0.710)	(0.070)	(0.255)
DWH test (*p*-value)	0.12	0.06	0.90	0.28
Observations	300	298	300	300
R-squared	0.059	0.091	0.608	0.441

Table 8

Decomposition of z-score and alternative risk-taking measures

The dependent variables are ROA, log of CAR, σ(ROA), and σ(RET), respectively. Results from three estimation methods are presented: Median is median quantile regression, Robust is robust regression or iteratively reweighted least squares, OLS is ordinary least squares with White heteroskedasticity-robust standard error. Sample consists of 300 financial firms. Regression variables are computed as the averages over 1998-2008, unless otherwise noted Following Houston et al (2010), ROA is return on assets and CAR is capital-asset ratio, both are averaged over 1998-2008. σ(ROA) is the standard deviation of ROA over 1998-2008. σ(RET) is the standard deviation of annual stock return over 1998-2008. Higher of ROA and CAR imply more stability. The ROA multiplied by 100 is used in regressions. *ln(at)* is the logarithm of total asset. *mb* is the market-to-book asset ratio. *dir* is the logarithm of median director dollar stockholding as of the last year in our sample period. *own* is CEO stock percentage ownership as of the last year in our sample period. *ibk* is dummy for investment banks, and *ins* is dummy for insurance companies. *Leverage* is debt/asset ratio.*,**, and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	ROA			ln(CAR)			σ(ROA)			σ(RET)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
VARIABLES	Median	Robust	OLS	Median	Robust	OLS	Median	Robust	OLS	Median	Robust	OLS
Ln(at)	0.00935	0.0141	0.383	-0.0312***	-0.0335***	-0.0763***	0.0283	0.0304	-0.0104	-0.0247	-0.0359***	-0.0369***
	(0.0117)	(0.0124)	(0.298)	(0.0110)	(0.00872)	(0.0145)	(0.0400)	(0.0303)	(0.0325)	(0.0191)	(0.0135)	(0.0124)
mb	4.300***	3.691***	5.977*	0.352***	0.232***	0.346***	0.657***	0.635***	0.743***	0.245**	0.323***	0.312***
	(0.0573)	(0.0734)	(3.438)	(0.0572)	(0.0475)	(0.117)	(0.195)	(0.177)	(0.231)	(0.103)	(0.0745)	(0.0949)
dir	0.0588***	0.0411**	0.156	-0.00825	-0.0203	-0.0305*	-0.127**	-0.157***	-0.147***	-0.0439	-0.0224	-0.0160
	(0.0180)	(0.0192)	(0.210)	(0.0172)	(0.0139)	(0.0176)	(0.0612)	(0.0460)	(0.0499)	(0.0291)	(0.0207)	(0.0209)
own	-1.660***	-1.059***	-3.535	0.382*	0.108	0.493	-1.684**	-1.128*	-0.926	0.873**	0.751***	0.397
	(0.217)	(0.254)	(8.267)	(0.198)	(0.169)	(0.339)	(0.761)	(0.594)	(0.818)	(0.355)	(0.263)	(0.447)
ibk	-0.358***	-0.368***	-4.139	0.875***	1.314***	0.689***	1.383***	0.764***	0.986***	0.476***	0.584***	0.632***
	(0.0849)	(0.0918)	(2.680)	(0.0709)	(0.0584)	(0.158)	(0.293)	(0.224)	(0.254)	(0.138)	(0.100)	(0.112)
ins	-0.0380	-0.0676	-0.483	0.163**	0.151**	0.206**	0.00432	-0.0513	0.0589	0.0741	0.160*	0.162*
	(0.0806)	(0.0855)	(0.895)	(0.0772)	(0.0615)	(0.104)	(0.264)	(0.205)	(0.172)	(0.130)	(0.0921)	(0.0854)
roa				-0.618*	-0.635**	-0.0300	-7.632***	-10.45***	-4.706**	-1.876***	-2.193***	-2.161***
				(0.368)	(0.317)	(0.813)	(1.300)	(1.242)	(2.163)	(0.637)	(0.470)	(0.486)
leverage	0.634***	0.998***	1.511				-2.903***	-4.163***	-3.304***	0.940**	1.168***	1.020***
	(0.221)	(0.273)	(11.28)				(0.816)	(0.624)	(0.787)	(0.386)	(0.280)	(0.301)
Constant	-5.070***	-4.583***	-12.02	-2.447***	-2.116***	-1.772***	-2.088**	-0.482	-1.231	-1.580***	-2.071***	-1.999***
	(0.286)	(0.337)	(11.20)	(0.227)	(0.183)	(0.263)	(1.037)	(0.792)	(0.883)	(0.502)	(0.355)	(0.372)
Obs	300	298	300	300	300	300	300	299	300	300	300	300
R^2		0.916	0.185		0.791	0.576		0.602	0.540		0.321	0.306

Table 9

Changes in risk for TBTF firms, differences-in-differences method.

The dependent variables are *z-score,* log of *z-score*, and *σ(RET),* respectively. Results from three estimation methods are presented: Median is median quantile regression, Robust is robust regression or iteratively reweighted least squares, OLS is ordinary least squares with White heteroskedasticity-robust standard error. Sample consists of 300 financial firms. Regression variables are computed as the averages over 1998-2008, unless otherwise noted. z-score =(ROA+CAR)/σ(ROA), where ROA=π/A is return on assets and CAR=E/A is capital-asset ratio, both averaged over 1998-2008. σ(ROA) is the standard deviation of ROA over 1998-2008. Higher z-score implies more stability. *Ln(z-score)* is natural logarithm of *z-score*. σ(RET) is the standard deviation of annual stock return over 1998-2008. *big* is dummy, which equals 1 for firms with total assets over $10 billion. *ln(at)* is the logarithm of total asset. *big_size* is interaction term of *big* and *ln(at)*. *mb* is the market-to-book asset ratio. *dir* is the logarithm of median director dollar stockholding as of the last year in our sample period. *own* is CEO stock percentage ownership as of the last year in our sample period. *ibd* is dummy for investment banks, and *ins* is dummy for insurance companies. *Leverage* is debt/asset ratio.*, **, and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	z-score			ln(z-score)			σ(RET)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Variables	Median	Robust	OLS	Median	Robust	OLS	Median	Robust	OLS
big	1.415	22.17	16.66	-0.372	0.280	0.981	-1.793***	-1.207***	-1.056**
	(26.65)	(25.27)	(24.14)	(1.233)	(0.990)	(0.941)	(0.434)	(0.424)	(0.411)
logat	-1.042	-1.201	-2.517	-0.0844	-0.0381	0.0464	-0.0752***	-0.0684***	-0.0606**
	(1.457)	(1.342)	(1.858)	(0.0678)	(0.0540)	(0.0860)	(0.0239)	(0.0236)	(0.0252)
big_size	-0.328	-2.015	-1.469	0.0418	-0.0223	-0.109	0.184***	0.121***	0.104**
	(2.667)	(2.527)	(2.490)	(0.124)	(0.0992)	(0.104)	(0.0435)	(0.0425)	(0.0410)
mb	-2.765	-3.641	-4.390**	-0.359**	-0.300**	-0.197	0.242***	0.321***	0.313***
	(4.038)	(3.808)	(2.013)	(0.182)	(0.150)	(0.164)	(0.0679)	(0.0731)	(0.0955)
dir	2.920**	3.958***	4.861***	0.160***	0.182***	0.143**	-0.0361*	-0.0170	-0.0115
	(1.319)	(1.213)	(1.751)	(0.0603)	(0.0474)	(0.0559)	(0.0209)	(0.0204)	(0.0214)
own	1.696	-9.829	-17.11	0.132	0.0120	-0.328	0.967***	0.734***	0.369
	(14.02)	(14.72)	(10.81)	(0.640)	(0.584)	(0.728)	(0.238)	(0.258)	(0.446)
ibk	-19.82***	-18.55***	-22.39***	-0.925***	-0.957***	-1.099***	0.345***	0.546***	0.605***
	(5.374)	(5.038)	(3.515)	(0.246)	(0.198)	(0.236)	(0.100)	(0.0990)	(0.116)
ins	-2.302	-1.273	-1.011	-0.00108	0.0147	-0.0322	0.0781	0.165*	0.165**
	(5.716)	(5.392)	(5.078)	(0.262)	(0.211)	(0.166)	(0.0919)	(0.0908)	(0.0818)
roa							-1.577***	-2.076***	-2.071***
							(0.384)	(0.467)	(0.465)
leverage							0.755***	1.189***	1.036***
							(0.255)	(0.276)	(0.307)
Constant	2.100	-7.191	-3.518	2.210***	1.432**	1.201	-1.150***	-1.924***	-1.902***
	(18.57)	(17.11)	(24.38)	(0.848)	(0.673)	(0.740)	(0.365)	(0.364)	(0.408)
Obs	300	300	300	298	298	298	300	300	300
R^2		0.138	0.136		0.201	0.211		0.344	0.319