Too-Big-to-Fail: The Value of Implicit Government Guarantee

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Abstract

Following the 2008 financial crisis and the government bailout of troubled companies, Too-Big-to-Fail became a standard expression to name a free protection of Wall Street by tax-payers’ money. What should have been the fair cost of this protection? We offer a novel approach to estimate the value of the implicit government guarantee by combining the contingent claim pricing with the likelihood of the government intervention. We find in our sample that the cost of this implicit protection can go beyond tens of billions of dollars with an average of about $13 million per company, per year, and it rises to about $24 million if the government is assumed to intervene with certainty. We then investigate the relationship between the implicit government guarantee and the funding costs of small and large banks. The funding costs for both small and large banks are related to the value of the implicit government guarantee. Moreover, we show that the spread of the funding costs of small banks over large banks is strongly associated with the value of the implicit government guarantee, especially after the crisis.

JEL Classification: G28, G10, C13.

Keywords: Too-Big-to-Fail, Bailout, Implicit Guarantee, Contingent Claim, Funding Cost.

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1. Introduction

Shedding some light on the 2008 financial crisis, Sorkin (2009) chronicles the story from the beginning of the crisis to the Troubled Asset Relief Program (TARP) and popularizes the concept of “Too Big to Fail” (TBTF). While saving the financial system, TARP was controversial as the cost of the bailout was mainly supported by the US tax payers. The idea of TBTF suggests that large companies enjoy a guarantee that they will be rescued by the government in a bankruptcy situation. As written by Bloomberg editorial board:

“On television, in interviews and in meetings with investors, executives of the biggest U.S. banks -- JPMorgan Chase & Co. Chief Executive Jamie Dimon -- make the case that size is a competitive advantage. It helps them lower costs and vie for customers on an international scale. Limiting it, they warn, would impair profitability and weaken the country’s position in global finance.

So what if we told you that, by our calculations, the largest U.S. banks aren’t really profitable at all? What if the billions of dollars they allegedly earn for their shareholders were almost entirely a gift from U.S. taxpayers?”

There is a common agreement that such an implicit guarantee exists and its cost may be justified due to the potential impact on the overall economy in case of the collapse of the financial system. At the same time, the implicit government guarantee reduces investors’ perception about the risk of the financial institution and their expected losses. It also leads to unfair competition due to lower cost of funds, increased risk taking by TBTF institutions and increased potential financial burden on the government. Policy makers have an intention to curb the value of the implicit government guarantee (Schich and Aydin [2014]), which creates a need for having a robust way of measuring it.

The contribution of this article is twofold. First, we propose a novel way to measure the value of the implicit government guarantee. Using our approach we find a confirmation for the

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1 From of Bloomberg View’s Editorials: Why Should Taxpayers Give Big Banks $83 Billion a Year?, February 20th, 2013
above Bloomberg editorial board view that the estimate of the implicit government protection can go beyond billions of dollars for some of the largest companies. Since the implicit government guarantee may potentially involve transfer of billions of dollars from the government to the bailed-out companies, the ability to estimate it remains an important public policy concern. Second, we investigate the relationship between the implicit government guarantee and the funding costs of small and large banks. The funding costs are often used as a proxy for the TBTF effect. Strong association between the spread of funding costs of small banks over large banks with our estimate of the implicit government guarantee serves as an additional confirmation of the validity of our model.

Quantifying the value of the implicit government guarantee has generated a considerable interest in the years following the financial crisis. The more common approaches of assessing the TBTF or the value of implicit government guarantee can be split into three groups: i) The funding cost approach; ii) The CDS-based approach; iii) The contingent claims approach.

The funding cost approach argues that the TBTF institutions enjoy lower costs of funds due to the implicit government guarantee. The implicit government guarantee is estimated as a reduction in the costs of funds that the TBTF institutions have compared to the costs of funds without the government guarantee. A number of papers (for example, Baker and McArthur (2009) and Li, Qu, and Zhang (2011)) estimate the reduction in the funding costs as the difference in the cost of funds of small and large (TBTF) financial institutions. It is assumed that only the large banks will be supported by the government in case of default. Several other papers (see, for example, Noss and Sowerbutts (2012), Ueda and di Mauro (2013), Lambert et al. (2014), and Schich, Bijlsma and Mocking (2014)) estimate the reduction in the funding costs based on credit
ratings. Credit rating agencies produce two credit ratings – an “individual” credit rating designed to assess institution’s strength on a stand-alone basis and a “support” rating which incorporates the probability that the institution will receive government support. The reduction in the funding costs in this case is estimated as the difference in the cost of funds based on higher “individual” rating and actual “support” rating. The implicit government guarantee is then calculated by multiplying the difference in the funding costs by the assets of the TBTF banks. The main drawback of the first approach is that it doesn’t control for the relative risk of different financial institutions and doesn’t take into consideration the likelihood of receiving government support. The rating-based approach avoids these problems, it is easy to implement, and the required data is readily available, but it suffers from being subjective and relying on credit rating agency judgement regarding creditworthiness of the company. In the aftermath of the financial crisis of 2007-2009, credit rating agencies have been heavily criticized for producing inaccurate credit ratings.

The CDS-based approach compares the difference between observed CDS spreads and modelled fair-value CDS spreads (FVS) calculated from the equity price information. Observed CDS spread is an indicator of the company’s perceived risk of default and it reflects the likelihood of government intervention and the size of government support in case of distress. The CDS-based approach usually assumes that equity holders are wiped out if company defaults. It implies that equity prices contain only information about the probability of company’s default and disregard the possibility of government intervention. Therefore, the FVS computed based on equity prices do not include the government guarantee. Several papers (see, for example, Schweikhard and Tsesmelidakis (2012) and Lambert et al. (2014)) use Merton (1974) model to estimate FVS, whereas Li, Qu, and Zhang (2011) use some proprietary model for this purpose.
The difference between the FVS and the observed CDS spreads is then used as a measure of the implicit government guarantee. The biggest drawback of this method is data availability. The CDS data is only available for large financial institutions, which limits the data sample. Another potential problem with this approach is the underlying model assumptions used to compute FVS, including the assumption that equity holders are not bailed out.

The contingent claims approach typically relies on Merton’s (1974) model. It is assumed that a firm has two types of claims – single homogeneous class of debt and the residual claim, equity. The implicit government guarantee is estimated by modeling the firm’s assets. The firm defaults when the value of the firm’s assets falls below some threshold (default barrier) at a future time, \( T \). Under the Merton’s model the firm cannot default before time \( T \). In case of default, the bondholders take over the firm and the shareholders get nothing. The value of the implicit government guarantee is computed as a put option on the firm’s assets with the strike price equal to the default barrier at some future time. It is assumed to be the sum necessary to restore the value of assets to the debt threshold. Most of the studies that use the contingent claims approach calculate the implicit government guarantee as an aggregate subsidy for all banks (see, for example, Noss and Somerbutts (2012), or Oxera (2011)). One potential problem related to this approach is the need to estimate the asset value and the asset volatility, which are unobservable and should be inferred from the equity market information. The techniques used in the literature estimate the asset value and volatility by simultaneously solving the system of two equations with two unknowns (see, for example, Lucas and McDonald (2009)), some papers rely on oversimplifying assumptions (for example, Noss and Somerbutts (2012) and Oxera (2011) assume that equity constitutes 6% of total assets) or use complex and resource-intensive techniques (for example, Jobst and Gray (2013)). Using the contingent claim approach implicitly assumes that the
government will intervene with certainty. However, on an individual basis, as evidence by the collapse of the Lehman Brothers, this intervention may fail to materialize. Therefore, it is necessary to take into account the likelihood of the government intervention for a given firm. The framework for estimating the likelihood of the government intervention is provided by Beliaeva, Khaksari and Tsafack (2015), who estimate it using the size and the finance industry membership of the company.

In this paper we combine the contingent claim approach with the likelihood of the government intervention to provide an appropriate and robust measure of the implicit government guarantee as the expected value of the contingent claim. This is simply the product of the probability of the government intervention and the value of the put option. We find that the cost of the government protection in our sample is, on average, about $24.5 million per company, per year, and it drops to $13.4 million when we incorporate the fact that the government may not intervene. Our estimates are also consistent with the Bloomberg View’s editorials, as we find that the value of the implicit government guarantee can go beyond billions of dollar for very large banks with trillions of dollar in assets and debts. The value of the implicit government guarantee sharply increases after the 2008 financial crisis.

Our empirical analysis reveals a consistently inverse relationship between funding costs and the value of the implicit government guarantee. This inverse relationship means that the decrease in the funding costs is associated with an increase in the value of the government guarantee for both large and small companies. Furthermore, we find that the spread in funding

\[ \text{To compute the contingent claim value, we derive an easily implementable solution for the asset value and asset volatility, which involves solving only one equation with one unknown instead of solving a system of two highly nonlinear equations at once.} \]
costs of small banks over large banks and the implicit government guarantee are positively related. In fact, the increase in the difference between the funding costs of small banks and large banks is often considered as a proxy for the *too-big-to-fail* premium. Therefore, the positive relationship confirms this intuition and reinforces our confidence in the way we estimate the value of the implicit government guarantee. Investigating potential structural break for the period after the crisis mostly confirms our results. The relationship between the funding cost spread and the implicit government guarantee is strong and positive both before and after the crisis for bank holding company data. For the FDIC data the results are only strong and positive after the crisis. Before the crisis the relationship is inverse which can be attributed to the FDIC insurance effect.

The remainder of the paper is organized as follows. Section 2 describes our methodology and the data set used to estimate the implicit government guarantee. Section 3 describes the methodology, the data, and the variables used for analyzing the relationship between our measures of the implicit government guarantee and funding costs. Section 4 presents and summarizes our empirical findings, and section 5 concludes.

### 2. Estimation of the Value of the Implicit Government Guarantee

#### 2.1. Definition

We define the value of the implicit government guarantee as the expected value of the government intervention to rescue the distressed firm. The value of the implicit government guarantee for company $i$ is computed as:

$$ E v_{g_i} = \pi_i \times v_{g_i} $$
Where, $\pi_i$ – the probability of the government intervention for company $i$;

$v_{g,i}$ – the value of the government subsidy given that intervention will happen with certainty for company $i$.

2.2. Estimating the Probability of the Government Intervention ($\pi_i$):

Following Beliaeva, Khaksari and Tsafack (2015), we use a Logit model to estimate the probability that the government will step in and rescue a company in distress. In our Logit model we use the finance industry indicator, the firm size, and the interaction term between these two variables as explanatory variables. The Logit model provides a simple way to describe the relationship between several explanatory variables and a binary dependent variable. We apply our model to an extensive dataset of 1571 bankrupt and bailed out companies between 2000 and 2015. The dependent variable in the Logit model estimates the probability that the government will step in and rescue a company in distress. It is defined as follows:

$$\text{Bailout}_i = \begin{cases} 
1, & \text{if firm is rescued by the government} \\
0, & \text{otherwise}
\end{cases}$$

The Logit model is then specified as follows:

$$\pi_i = \text{Prob}(\text{Bailout}_i|\text{Distress}) = F(\beta_0 + \beta_1 \text{lgasset} + \beta_2 \text{Dum}_{Fin} + \beta_3 \text{lgasset} \times \text{Dum}_{Fin})$$

Where, $F(\cdot)$ – the Logit function;

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3 It is worth noting that this probability is conditional on distress. Therefore, it doesn’t need to be controlled by macro factors. To understand this better, let D be the event representing the company being in distress and B represent the bailout. Using the fact that the bailout only happens when the company is in distress, we can write the unconditional probability of bailout as $\text{Prob}(B) = \text{Prob}(D,B) = \text{Prob}(B|D) \times \text{Prob}(D)$. The fact that companies are (more likely to be) bailed out during the time of macroeconomic distress will mostly affect Prob(D) rather than Prob(B|D). In this step we are estimating the conditional probability, $\pi_i = \text{Prob}(B|D)$, while the probability of distress, Prob(D), is accounted for by the estimation of the contingent claim, $v_{g,i}$. 
\( \text{lgasset}, \) – the natural logarithm of the total assets;

\( \text{Dum}_{\text{Fin}}, \) – the dummy variable indicating whether the company belongs to the finance industry or not;

\( \text{lgasset} \times \text{Dum}_{\text{Fin}} \) – the interaction term between the log of the total assets and the finance industry membership.

2.2.1. The Government Guarantee Data and Results

The data that we use to estimate the implicit government guarantee comes from several major sources: SDC Platinum database, TARP database and ProPublica website. SDC Platinum database includes all US public companies with $10 million or more in assets that file for Chapter 11 bankruptcy protection. We compile a broad sample of Chapter 11 bankruptcy filings spanning the years 2000 through 2015 (SDC coverage begins in 1980). We exclude firms with reported assets under $100 million. The list of bailout firms is obtained from the ProPublica’s website and the TARP database.

[Insert Table 1 Here]

Panel A of Table 1 summarizes the number of bailout and bankrupt firms in our sample. We have a total of 1,247 bankruptcy cases, including 175 finance firms, and 324 bailout firms, including 304 finance firms. Panel B of Table 1 provides summary statistics for the variables used in the estimation of the probability of the government intervention. The average of the total assets is 12 billion dollars. We normalize the total assets by taking the natural logarithm of the total assets (\( \text{lgasset} \) hereafter). The average of \( \text{lgasset} \) is 6.79 with the standard deviation of 1.53. Panel C of Table 1 shows the correlation coefficients among these variables. We observe
a 0.685 correlation between the finance industry dummy variable and the bailout dummy variable and 0.36 correlation between the log of total assets and the bailout dummy variable.

[Insert Table 2 Here]

We analyze four different model specifications. In model 1 and model 2 we estimate the effects of the financial industry (finance dummy) and the firm size (log of total assets) on the probability of the government intervention, respectively. We include both variables in model 3. To examine the interaction effects, in model 4 we include an additional interaction variable between the finance industry dummy and the log of the total assets. The results of the Logit regression estimation for four model specifications are presented in Table 2. All of the parameter estimates are significant at a 1% level across all models. Although the size and the financial industry membership are the two main factors explaining the probability of the government intervention, the addition of the interaction variable between the firm size and the finance industry dummy increases the explanatory power of the model. In fact, model 4 is the best fitting model out of the four model specifications as evidenced by the lowest AIC criteria of 733.67 and the highest Pseudo $R^2$ of 64.03%. Therefore, we choose Model 4 specification to estimate the probability of the government intervention for all firms in our full sample. The negative sign for the coefficient of the interaction variable seems counterintuitive as the TBTF is mostly related to the financial institutions. A straightforward interpretation of the negative sign is that while the size matters for a bailout of any firm, it is more important for non-finance firms relative to finance

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4 Note that the data sample used to estimate the probability of the government intervention involves only those companies that were bailed out or those that went bankrupt. Glover (2016) points out that estimates based on the sample of distressed firms may suffer from the selection bias. This might have been a problem if we were estimating the expected cost of bailout. Since here we are estimating the probability of the bailout conditional on the company being in distress, there will be no such bias. Such estimation, in fact, requires a sample of only distressed companies, which ultimately either went bankrupt or were bailed out.
firms. This result can be justified by the fact that there is a strong correlation between credit risks of large and small banks. This is especially true for our sample. The TARP program for the bailout of the financial system included both very large banks as well as small banks. In contrast, non-finance companies’ bailout had more homogeneity: firms rescued in 2001 were mostly big airline companies. Therefore, while the firm size matters for a bailout decision, within the financial system, the size effect for individual financial institutions is overshadowed by the risk of the contagion effect. Due to this, the firm’s size is not the main driving factor of the bailout decision within the financial industry.

It also worth noting that our estimation procedure does not include a dummy variable for the crisis period. Although the bailout is related to the economic environment, including a variable indicator for the crisis period will introduce some endogeneity in the estimation of the likelihood of the government intervention for a given company. In fact, when TBTF companies are in trouble, it tends to trigger both a crisis and a bailout program. This can be seen in our sample as we have bailouts only during the crisis period, which can give a false impression that a bailout cannot occur without a crisis. In our study we are more interested in the probability of the government intervention for a given firm, even if the company is far from a distress situation. We expect the crisis effect to be captured by the value of the contingent claim.

Using the estimated parameters, we fit the data to the following Logistic function:

\[
\pi_i = \frac{\exp(\beta_0 + \beta_1 \text{lgasset} + \beta_2 \text{Dum}_{\text{Fin}} + \beta_3 \text{lgasset} \times \text{Dum}_{\text{Fin}})}{1 + \exp(\beta_0 + \beta_1 \text{lgasset} + \beta_2 \text{Dum}_{\text{Fin}} + \beta_3 \text{lgasset} \times \text{Dum}_{\text{Fin}})}
\]

The above equation is used at a company level to derive the likelihood of the government intervention which is then incorporated into the calculation of the value of the implicit government guarantee.
2.3. Estimating the Value of the Government Subsidy Given Intervention ($V_i$)

We estimate the value of the government subsidy given that intervention will happen with certainty (i.e. assuming the “full coverage” by the government) using the contingent claims approach of Merton (1974). Under this approach it is assumed that the firm has a simple capital structure consisting of equity and a single homogeneous class of debt. The firm’s equity value is modelled as a call option on the firm’s assets with the exercise price equal to the firm’s default barrier (firm’s liabilities). If at the option’s maturity the asset value is less than the strike price, then the option expires worthless, shareholders get nothing and the firm is turned over to the debtholders. The value of the implicit government guarantee is analogous to a put option on the firm’s assets with the strike price equal to the default barrier (firm’s liabilities). If at option’s maturity the asset value is less than the strike price, then the option is in-the-money and the option payoff (i.e. payoff from the government) is equal to the difference between the strike price (the firm’s liabilities) and the firm’s assets. It is represented as a claim that firms have on the government contingent on their failure, the exercising of which restores their assets to a value necessary to prevent their default. The estimation of the value of the government subsidy is done in two steps:

**Step 1.** Estimate $V_A$ (the value of assets) and $\sigma_A$ (the volatility of assets) by solving a system of two equations based on Black and Scholes (1973) and Merton (1974).

*Equation 1:* The value of equity expressed as a call option on the firm’s assets:

$$V_E = V_A \times N(d_1) - L \times e^{-rT} \times N(d_2),$$

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5 This approach is similar to that described in Crosbie and Bohn (2003) and Vassalou and Xing (2004).
\[
    d_1 = \frac{\ln \left( \frac{V_A}{T} \right) + \left( r_f + \frac{1}{2} \sigma_A^2 \right) \tau}{\sigma_A \sqrt{\tau}} \\
    d_2 = d_1 - \sigma_A \sqrt{\tau}
\]

Where, \( V_A \) – the value of assets, \\
\( \sigma_A \) – the volatility of assets, \\
\( V_E \) – the value of equity, \\
\( \sigma_E \) – the volatility of equity, \\
\( L \) – the firm’s existing liabilities (senior debt, subordinated debt, preferred equity).

**Equation 2:** The relationship between the value of equity and the volatility of assets:

\[
    V_E = \frac{\sigma_A}{\sigma_E} \times V_A \times N(d_1)
\]

Given the equity volatility data, the risk-free rate, the market value of equity, and the face value of debt, it is necessary to solve the system of these two highly non-linear equations to estimate the value of assets and the volatility of assets. We derive an easily implementable solution for the assets value and assets volatility which involves solving only one equation with one unknown. Technical details on the estimation procedure are provided in Appendix A.

**Step 2.** Compute the value of the implicit government guarantee given intervention as a put option on the firm’s assets with the strike price equal to the default barrier (the firm’s liabilities).
\[ v_i = L \times e^{-\tau \tau} \times N(-d_2) - V_A \times N(-d_4) \]

For a given company \( i \), this represents the value of the government guarantee given that the intervention will happen with certainty.

3. Government Guarantee and the Funding Costs

3.1. The Model Specification

It is often assumed that only large financial institutions will be supported by the government in case of default\(^6\). Therefore, the difference in the costs of funds between small and large financial institutions can be thought of as a proxy for the implicit government guarantee. In this section we investigate the relationship between our measure of the value of the implicit government guarantee, \( Ev_g \), and the funding cost variable while also controlling for the GDP growth rate.\(^7\) We use the following model specification:

\[ Ev_g = \alpha_0 + \beta \times \text{FundingCost} + \gamma \times \text{GDP Growth}, \]

To investigate the potential change in the relationship between of the value of the implicit government guarantee and the funding cost, we introduce an interaction variable between the funding cost and the crisis indicator as follows.

\[ Ev_g = \alpha_0 + \beta \times \text{FundingCost} + \delta \times \text{AfterCrisis} \times \text{FundingCost} + \gamma \times \text{GDP Growth}, \]

\(^6\) This is the premises of the funding cost approach (see, for example, Baker and McArthur (2009) and Li, Qu, and Zhang (2011)).

\(^7\) We focus on GDP Growth as a control variable for macro environment because it captures the overall health of the economy. We do not include interest rate as a control variable in order to avoid potential endogeneity problem, given that interest rate is also used to estimate the contingent claim. Other variables were also excluded because of multicollinearity issues.
Where, $After\text{Crisis}$ – a dummy variable taking a value of one after the crisis and zero otherwise.

To study the relationship between the value of the implicit government guarantee and the funding cost variable, we sort our data sample into two groups by bank size. Following Li, Qu, and Zhang (2011), we define the top 20 in book assets as of December of each year as large banks and the remainder as small banks. We separately analyze the relationship between the implicit government guarantee and the funding costs of large banks, small banks and the difference in the funding costs of small and large banks.

The analysis of the relationship between the implicit government guarantee and the funding cost variable provides an alternative way to assess the robustness of our results.

3.2. Funding Cost Measure

The bank’s funding cost, i.e. the interest rate charged by the bank’s creditors, depends on the lender’s perception of the bank’s probability of distress. In other words, the lenders assess the bank’s default probability and adjust the interest rate they charge accordingly. There are two ways to obtain data on interest rates and default probabilities for any given bank.

First, interest rates and default probabilities can be extracted from the market data. A popular proxy for the bank’s funding cost is CDS spread, which can also be used to imply the bank’s default probability. However, the limitation of this approach is that the CDS data is not widely available for small banks. An alternative source of data on the bank’s funding cost and default probability is the bank’s balance sheet reports. The data on the bank’s interest expense on debt allows to construct proxies of funding costs. Baker and McArthur (2009) use the FDIC data
for depository institutions to compare the average cost of funds for large banks against small banks. Since the FDIC data is at the depository bank level, this analysis does not cover the consolidated bank holding company level where additional funding costs may arise. In addition to using funding costs incurred by depository institutions as reported by the FDIC, we construct funding costs using banks’ corporate level balance sheet data from COMPUSTAT Bank database.

Following Araten and Turner (2013), we use the cost of deposit as a measure of funding cost. It is defined as a ratio of the total interest expense on interest bearing liabilities to the average total interest bearing liabilities:

\[
Funding\ Cost = \frac{Interest\ Expense\ on\ Interest\ Bearing\ Liabilities}{Average\ total\ interest\ bearing\ liabilities}
\]

The funding cost measure is computed on quarterly basis. The interest expense on interest bearing liabilities (i.e. interest bearing debt) includes interest paid on certificates of deposit, savings certificates, saving deposits and time deposits. The average total liabilities are computed as the average of the ending total liabilities of quarter \( t \) and the ending total liabilities in the previous year.

Existing literature has examined alternative measures of funding costs, such as the average funding cost and the interbank funding cost (see, for example, Araten and Turner (2013) and Aymanns, Caceres, Daniel and Schumacher (2016)). However, these two measures may not be appropriate for our study. The average funding cost measure includes payments made to all of the bank’s creditors, including both retail and wholesale depositors. As noted by Araten and Turner (2013), the composition of the average funding cost is different for large and small banks, in which large banks have various sources of funds, while small banks largely rely on regular deposits. As a result, the average funding cost of large banks tends to be upward biased due to
the mix of funding cost. The interbank funding cost measure is calculated as a ratio of interest expense on federal funds and repos purchased to the average total federal funds and repos purchased during the reporting period. The large banks are more likely to use federal funds and repos for short-term borrowing, while small banks have limited access to them. In fact, the cost of federal funds makes up only 6% of the overall funding costs of small banks as reported by Araten and Turner (2013). Due to the shortcomings of the alternative funding cost measures, in our study we define the funding cost as the cost of deposit.

3.3. Bank Funding Cost Data

The banking data is obtained from the COMPUSTAT Bank database and the Federal Deposit Insurance Corporation (FDIC). The COMPUSTAT Bank database contains data on all publicly listed US banks and consolidates bank data at bank holding company level. We begin by using 1440 banks from COMPUSTAT. The FDIC dataset contains more than 10,000 US depository institutions over the same sample period. To estimate funding cost, we require that the banks have positive total assets with non-missing data on interest bearing debt and interest expenses on interest bearing debt. The final sample consists of 106 listed banks from COMPUSTAT and 10,638 depository institutions from FDIC.

[Insert Figure 1 Here]

To conduct a funding cost analysis of large and small banks over the 2000 to 2015 period, we define large or TBTF banks as the top 20 banks in book assets for each period.8 Figure 1 compares the funding cost differences between small and large banks before, during and after

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8 We also look at an alternative definition of large banks: for a given quarter large banks are defined as banks with book asset over $100 billion. Such alternative definition does not change our results substantially.
the crisis period. Using the NBER business cycle data, the pre-recession period is defined as the one year period before the peak of the recession and the post-recession period is defined as the one year period after the trough of the recession. The recession period starts at the peak of the recession and ends at the trough. The funding cost is calculated as the average of the yearly medians of annualized quarterly funding costs during the designated period. As shown in Figure 1, the funding cost difference between small BHCs and large BHCs is -30 bps during the pre-crisis period. The funding cost gap increases by 24 bps from -30 bps to -6 bps during the crisis period, suggesting that due to the implicit government guarantee the funding cost for large BHCs decreased more compared to that of the small BHCs. Moreover, large BHCs have an 8 bps funding cost advantage over small BHCs during the one year post crisis period implying that large BHCs continued enjoying the implicit government guarantee after the crisis. Figure 2 shows that the funding cost advantages of the large banks continues for 2 years after the trough of the crisis and then it gradually narrows down.

[Insert Figure 2 Here]

For the FDIC banks the funding cost advantage for large banks is even stronger. As Figure 1 shows, the funding cost difference between small and large banks is -11 bps during the pre-crisis period, it increases to 55 bps during the crisis period, and to 89 bps during the one year post crisis period. Figure 2 shows that the funding cost advantages of the large banks over the small banks is still big (79 bps) two years after the crisis. Our findings provide strong evidence that the large banks enjoy funding cost benefits associated with the TBTF status.

An important point we want to address here is the FDIC insurance effect on the funding cost. The FDIC insurance protects the funds depositors place in banks and saving associations
against the losses associated with the failure of the FDIC insured institution. FDIC deposit insurance is backed by the full faith and credit of the United States government. The standard deposit insurance amount is $250,000 per depositor, per insured bank, for each account ownership category. In the event of a bank failure, FDIC pays insurance to depositors up to the insurance limit. Funding cost is the interest rate charged by the bank’s creditors, reflecting lender’s perception of the bank’s creditworthiness. Thus, the FDIC insurance can potentially lower the funding costs for FDIC insured institutions. The effect should be stronger for small banks because small banks are more likely to attract deposits from ordinary depositors with the deposit amount below the insurance limit while large banks have a large variety of clients with the large variation in deposit amounts. Our findings show that before the crisis small FDIC banks had lower funding costs compared to the large banks which could be partially attributed to the FDIC insurance effect. However, this relationship reversed during and after the crisis. While funding costs decreased for both small and large FDIC banks, the reduction was much bigger for the large FDIC banks resulting in significantly lower costs of funds for the large banks compared to the small banks. This suggests that during and after the crisis the FDIC insurance effect is not significant and it is overpowered by the increase in the value of the implicit government guarantee.

3.4. Summary statistics

We provide below the summary statistics for the value of the contingent claim, the expected value of the implicit government guarantee, the leverage, and the funding cost.

[Insert Table 3 Here]
Panel B and Panel C of Table 3 provide summary statistics of banks’ fundamental and funding cost variable from 2000 to 2015 for BHCs and FDIC banks, respectively. Bank fundamental variables include total assets, total debt, total liabilities and leverage. For our sample of banks, the mean (median) of total assets is $129.74 (27.07) billion for BHCs and $1.45 (0.13) billion for FDIC banks, while the mean (median) of total liabilities is $117.36 (24.12) billion for BHCs and $1.30 (0.12) billion for FDIC banks. For BHCs, the funding cost ranges from 0.02% to 10.49% with the mean (median) of 2.05% (1.76%). For FDIC banks, the funding cost ranges from 0.07% to 8.48% with the mean (median) of 2.38% (2.19).

[Insert Table 4 Here]

Panel B and Panel C of Table 4 provide summary statistics of the time series funding cost, size and leverage variables separately for large banks, small banks, and for the difference between small and large banks from 2000 to 2015 for BHCs and FDIC banks, respectively. The mean size of large BHCs is 11 times bigger than that of the small ones ($171.4 billion versus $15.5 billion). The mean leverage of the large banks is about 18.8%, which is 4.5% higher than that of the small banks. The mean funding cost of large BHCs is 1.71% which is about 0.03% higher than that of the small BHCs. At the same time, the mean size of large FDIC banks is over 1000 time bigger than the size of the small FDIC banks ($150.3 billion versus $0.14 billion). The mean funding cost of large FDIC banks (1.68%) is on par with the mean funding cost of large BHCs, however, the funding cost of small FDIC banks is 2.1% which is 0.42% above that of the large FDIC banks. This difference in the funding costs between small BHCs and small FDIC banks can be explained by the fact that the mean size of banks in the small FDIC bank sample is over 100 times smaller than the mean size of the small BHCs.
4. Empirical Analysis

In this section we report the results of our empirical analysis. First, we compute the value of the implicit government guarantee using the two step procedure outlined in section 2. Then, we relate the value of the government guarantee to funding costs of large banks, small banks, and the funding cost spread between small and large banks while controlling for the macroeconomic conditions.

4.1. The Value of the Implicit Government Guarantee

Using the firms’ equity and liability data at the beginning of the quarter,\(^9\) we estimate the value of the government subsidy given intervention as a put option on the firm’s assets with the strike price equal to the default barrier (firm’s liabilities).\(^10\) Panel A of Table 3 shows that the average value of the implicit contingent claim over a one year maturity is $23.68 million, with the maximum of $111.2 billion. This value represents the value of the government guarantee under the assumption that the guarantee is explicit, i.e. that the government will rescue the troubled companies with certainty. In practice, as the Lehman Brothers bankruptcy has shown, this is not the case even for large banks. One of the contributions of our study is that we define the value of the implicit government guarantee as an expected value of the government intervention and we estimate it by multiplying the value of the government subsidy given certain intervention by the probability of the government intervention. We estimate the average probability of the government intervention to be 15%. We also find that large firms and financial institutions are

---

\(^9\) For the volatility of the equity, we use the EWMA filter to estimate from quarter to quarter, starting with the volatility estimated on the entire series for each company. We also look at an alternative definition using daily stock returns over the past 12 months. We find that the results are very similar.

\(^10\) Following Levine and Wu (2016) and Vassalou and Xing (2004), we use one year as the time to maturity for the put option.
more likely to receive government support, while a large number of small firms may not be bailed out by the government. After taking into account the probability of the government intervention, we find that the average expected value of the implicit government guarantee for all firms is $12.91 million but it can be as high as $89.2 billion for certain companies. This can be interpreted as the average annual cost of the Too Big to Fail per company for the tax payers. According to the TARP, the total government disbursement was $623 billion. Specifically, the top recipients were Fannie Mae ($116 billion), Freddie Mac ($71 billion), AIG ($67 billion), GM ($50 billion), and the Bank of America ($50 billion). Therefore, our measure of the value of implicit government guarantee can well capture the size of the recent government bailout.

In addition, we take the quarterly mean of the estimated government guarantee variables to get the time-series data for the subsequent analysis. Panel A of Table 4 shows that the value of the contingent claim over a one year maturity ranges from about $376,000 to $87 million, with a $24.5 million on average. The probability of the government bailout ranges from 4.53% to 17.73% with an average of 15.32%. The mean (median) of the expected value of the implicit government guarantee for all firms over the sample period is $13.38 ($4.07) million. Also note that the product of the average probability with the contingent claim ($24.5 \times 0.1532 = $3.75 million) is much smaller than the average value of the government guarantee ($13.38 million). This can be explained by the fact that big companies with large values of contingent claims also have higher likelihood of the government intervention.

[Insert Figure 4 Here]

Figure 4 plots the evolution of the value of the implicit government guarantee and LIBOR interest rate from 2000 to 2015. The value of the implicit government guarantee was quite low
before the financial crisis and it dropped virtually to zero in the end of 2008, following the Lehman Brothers bankruptcy. To deal with the financial crisis the Federal Reserve pushed interest rates to their historical minimum and kept them at that level through 2015. After the financial crisis, the value of the implicit government guarantee increased significantly, reaching its peak in the middle of 2011, but it has declined in the following years. The high level of the implicit government guarantee after the financial crisis coupled with the low interest rates reflects the fact that the government continued stabilizing the economy well after the financial crisis was over. While the goal was to restore confidence in the economy and stability of the financial system, such policy came at a cost. It put a fiscal strain on the economy, reduced the GDP and delayed the economic recovery.

[Insert Figure 5 Here]

Figure 5 shows that the value of the implicit government guarantee increased drastically with the crisis for both finance and non-finance companies. Since non-finance companies have larger average size compared to finance companies ($2.7 billion versus $1.6 billion), the average value of the implicit government guarantee for non-finance companies before the crisis was slightly larger compared to that of the finance companies ($3.1 million versus $2.3 million). After the crisis the situation reversed and the finance companies enjoyed a much larger average implicit government guarantee ($31.6 million) compared to that of the non-finance companies ($24.4 million). When we consider the ratio of the average value of the implicit government guarantee to the companies’ average market value, the finance companies had larger ratios both before and after the crisis. The difference in ratios between finance and non-finance companies is more
pronounced after the crisis. This is consistent with the financial sector bailout which was done in order to prevent the collapse of the entire economy.

4.2. The Relationship between the Value of the Implicit Government Guarantee and the Funding Costs

The spread between the funding costs of the small and large banks is often used as a proxy for the too-big-to-fail effect of the implicit government guarantee (see, for example, Baker and McArthur (2009) and Li, Qu, Zhang (2011)). The intuition behind it is that the decrease in the funding costs of large banks relative to the funding costs of smaller banks and subsequent increase in the funding costs spread can be associated with an increase in the value of the implicit government guarantee. We investigate this relationship for the costs of funds using data at BHC level from Compustat and at depositary level from FDIC.

The value of the implicit government guarantee depends on the current economic conditions. To control for the state of the economy we use the GDP growth rate. Empirical evidence shows strong inverse relationship between the implicit government guarantee and the funding costs (see Table 6 and Table 8). There is a significant consistency in our results. The strong negative relationship holds for large and small companies for both BHC and FDIC funding costs measures. The inverse relationship means that a decrease in the funding costs is associated with an increase in the value of the implicit government guarantee for both large and small companies.

[Insert Table 6 Here]

In Table 6, the one percent decrease of funding cost of large banks is associated with $744,023 increase of the value of implicit government guarantee using the BHCs data. While this
result is secondary and can be influenced by other factors, the most interesting result is the positive relationship between the spread in funding costs of small banks over large banks and the implicit government guarantee.

[Insert Table 7 Here]

Table 7 shows the one percentage increase of funding cost spread is associated with the $5.44 million increase of the implicit government guarantee. Since the spread between the funding costs of the small and large banks is often considered as a proxy for the too-big-to-fail premium, the positive relationship confirms this intuition and reinforces our confidence in the way we estimate the value of the implicit government guarantee.

[Insert Table 8 Here]

We also observe a strong positive relationship between the banks’ size and the implicit government guarantee for both small and large BHCs and FDIC banks. The positive relationship implies that larger companies enjoy higher implicit government guarantee. Finally, we explore the relationship between banks’ leverage level and the implicit government guarantee for BHCs. We find strong inverse relationship for both large and small BHCs meaning that highly leveraged banks tend to have lower implicit government guarantee.

[Insert Table 9 Here]

After the financial crisis many companies reduced the amount of leverage which increased their implicit government guarantee.

4.3. Crisis Effect on the Relationship between the Value of the Implicit Government Guarantee
and the Funding Costs

In this section we explore the effect of the financial crisis on the relationship between the value of the implicit government guarantee and the funding cost spread between small and large banks. To explore this relationship we add a structural break to distinguish between before and after the crisis periods. The empirical results, for the most part, are consistent with our prior findings (see Table 7 and Table 9). For BHCs, the relationship remains strong and positive both before and after the crisis. Before the crisis, the funding cost spread was increasing and so was the implicit government guarantee. After the crisis there is usually a reversal adjustment as the markets gradually return to normal. The positive after the crisis relationship implies that as the funding cost spread narrowed, the implicit government guarantee decreased. For the FDIC banks the relationship is strong and positive after the crisis but it is negative before the crisis. This result can be attributed to the FDIC insurance effect, which reduces the cost of funds of the FDIC insured financial institutions. As was discussed earlier, the FDIC insurance effect should be stronger for small FDIC banks leading to a decrease in the funding cost spread between small and large banks before the crisis at the time when the implicit government guarantee was growing. The FDIC insurance effect becomes insignificant during and after the crisis, which is confirmed by the positive relationship between the value of the government guarantee and the funding cost spread after the crisis.

4.4. Robustness Check

We perform the robustness check of our results by considering an alternative definition of the large banks. Instead of defining large banks as the top 20 banks in each quarter, we use Baker and McArthur (2009) definition, who define large banks as banks with more than $100
billion in total assets and small banks as banks with less than $100 billion in assets. For BHCs we have 7 to 16 large banks over the sample period; for FDIC banks there are 8 to 24 large banks. The samples are similar to the previous definition, but with smaller number of banks in early 2000s and more banks in recent years. This makes sense because there is an overall increase in the size of banks over the sample period. We repeat the regression analysis as specified in the previous section, but compute the funding cost variables based on the alternative definition. To save the space, the empirical results are reported in the online appendix.

The results of regressions with the alternative definition of large banks are very consistent with the results obtained with the original definition. They confirm a strong inverse relationship between funding costs and the implicit government guarantee for large and small banks for both BHCs and FDIC banks. They also confirm a strong positive relationship between the funding costs spreads of small banks over large banks and the implicit government guarantee once again supporting the TBTF effect. The introduction of the structural break to differentiate between before and after the crisis periods, has a similar effect on the signs of the coefficients as the original definition of the large banks but the resulting coefficients are less significant. Overall, the regressions with the alternative definition of the large banks strongly support and confirm our findings that there is a strong relationship between funding costs and the implicit government guarantee.

5. Conclusion

The contribution of our paper is twofold. First, we provide a robust way to estimate the value of the implicit government guarantee and, second, we investigate the link between the
value of the implicit government guarantee and the funding cost spread between small and large banks.

Combining the contingent claim pricing with the likelihood of the government intervention, we estimate the value of a potential bailout enjoyed by the firms. Our estimates support the Bloomberg View’s editorials, as we find that the value of the implicit government guarantee can go beyond billions of dollar for very big banks with trillions of dollars in assets and debts. Furthermore, we find that the value of the implicit government guarantee sharply increased after the 2008 financial crisis.

Since the TBTF dynamics is often approximated by the change in the spread of the funding cost of small banks relative to large banks, we assess that by constructing the time-series of funding costs of large and small banks. We find that the funding cost spread is strongly related to our estimate of the value of the implicit government guarantee. When we introduce a structural break in the relationship, we find that the relationship is much stronger and more consistent after the financial crisis.
Appendix A. Solving for the Value of Assets, $V_A$, and the Volatility of Assets, $\sigma_A$.

The value of assets, $V_A$, and the volatility of assets, $\sigma_A$, are obtained from the following system of two equations:

\[
\begin{align*}
V_E &= V_A \times N(d_1) - L \times e^{-\tau r_f} \times N(d_2) \\
V_E &= \frac{\sigma_A}{\sigma_E} \times V_A \times N(d_1)
\end{align*}
\]

Combining equations (1) and (2) leads to

\[
V_E = V_E \times \frac{\sigma_E}{\sigma_A} - L \times e^{-\tau r_f} \times N(d_2)
\]

Which implies

\[
d_2 = N^{-1} \left[ \frac{V_E \left( \frac{\sigma_E}{\sigma_A} - 1 \right)}{L \times e^{-\tau r_f}} \right]
\]

On another hand, $d_2$ is given by

\[
d_2 = d_1 - \sigma_A \sqrt{\tau} = \frac{\ln \left( \frac{V_A}{L} \right) + \left( \tau_f + \frac{1}{2} \sigma_A^2 \right) \tau}{\sigma_A \sqrt{\tau}} - \sigma_A \sqrt{\tau}
\]

Equating these two expressions [(3) and (4)] of $d_2$ and solving for $V_A$ leads to

\[
V_A = L \times \exp \left[ \sigma_A \sqrt{\tau} \left( N^{-1} \left[ \frac{V_E \left( \frac{\sigma_E}{\sigma_A} - 1 \right)}{L \times e^{-\tau r_f}} \right] + \sigma_A \sqrt{\tau} \right) - \left( \tau_f + \frac{1}{2} \sigma_A^2 \right) \tau \right]
\]

This expression shows that the value of assets can be written as a function of the volatility of assets

\[
V_A = h(\sigma_A)
\]

On the other hand, we can use this relation in the expression of $d_1$ to write

\[
d_1 = d_1(\sigma_A)
\]

And it follows from equation (2) that

\[
f(\sigma_A) = \sigma_E V_E - \sigma_A h(\sigma_A) N\left(d_1(\sigma_A)\right) = 0
\]

Given the data on the market value of equity, $V_E$, the book value of debt, $L$, equity volatility, $\sigma_E$, and risk-free rate, $\tau_f$, we use equation (6) to solve for assets volatility, $\sigma_A$. Once the value of $\sigma_A$ is obtained, we use equation (5) to back out the value of assets, $V_A$. Following Levine and Wu (2016) and Vassalou and Xing (2004), we assume an estimation window of one year, i.e. $\tau = 1$, and estimate the face value of debt as the
sum of debt due within the next year and one half of the long term debt. The risk-free rate is given by the one-year Libor rate obtained from Bloomberg. $\sigma_e$ is estimated using the EWMA filter to estimate from quarter to quarter, starting with the volatility estimated on the entire series for each company.
## Appendix B. Variable Definitions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>$v_g$</td>
<td>Value of the contingent claim (put option)</td>
</tr>
<tr>
<td>$\pi_i$</td>
<td>Probability of the government bailout</td>
</tr>
<tr>
<td>$E v_g$</td>
<td>Value of the implicit government guarantee (expected value of the put option)</td>
</tr>
<tr>
<td>Dum_Bailout</td>
<td>Dummy variable taking the value of 1 if the firm is bailed out, and 0 if not</td>
</tr>
<tr>
<td>Dum_Finance</td>
<td>Dummy variable taking the value of 1 for finance firms, and 0 for non-finance firms</td>
</tr>
<tr>
<td>Lgasset</td>
<td>The natural logarithm of the total assets of the firm</td>
</tr>
<tr>
<td>FCostLarge</td>
<td>Funding costs for large banks</td>
</tr>
<tr>
<td>FCostSmall</td>
<td>Funding costs for small banks</td>
</tr>
<tr>
<td>FCostDiff</td>
<td>Difference between funding costs of small and large banks (Small – Large)</td>
</tr>
<tr>
<td>SizeLarge</td>
<td>Size (average asset value) of large banks</td>
</tr>
<tr>
<td>SizeSmall</td>
<td>Size (average asset value) of small banks</td>
</tr>
<tr>
<td>SizeDiff</td>
<td>Difference in size (average asset value: Large – Small)</td>
</tr>
<tr>
<td>LevLarge</td>
<td>Average leverage for large banks</td>
</tr>
<tr>
<td>LevSmall</td>
<td>Average leverage for small banks</td>
</tr>
<tr>
<td>LevDiff</td>
<td>Difference in average leverage of small and large banks (Small – Large)</td>
</tr>
<tr>
<td>AfterCrisis</td>
<td>Dummy variable taking the value of 1 after the crisis, and 0 otherwise</td>
</tr>
<tr>
<td>GDP Growth</td>
<td>Growth rate of the GDP</td>
</tr>
</tbody>
</table>
Reference


Figure 1. Funding Cost Difference: Bank Holding Companies verses FDIC banks

**Pre-Recession Period**
- BHC: 3.88%
- FDIC: 3.84%
- Difference: 0.04%

**Recession Period**
- BHC: 3.08%
- FDIC: 3.14%
- Difference: 0.06%

**Post-Recession Period**
- BHC: 1.70%
- FDIC: 2.43%
- Difference: 0.73%
Figure 2. Dynamics of the Funding Costs for BHC banks: Large, Small and Difference

Figure 3. Dynamics of the Funding Costs for FDIC banks: Large, Small and Difference
Figure 4. Evolution of the Value of the Implicit Government Guarantee and Interest Rate
Figure 5. The crisis effect on the value of implicit government guarantee

**Average value of implicit government guarantee for finance and non-finance companies before and after the crisis (in $million)**

<table>
<thead>
<tr>
<th></th>
<th>Finance</th>
<th>Non Finance</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEFORE CRISIS</td>
<td>2.33</td>
<td>3.08</td>
</tr>
<tr>
<td>AFTER CRISIS</td>
<td>3.160</td>
<td>24.35</td>
</tr>
</tbody>
</table>

**Average Market value for finance and non-finance companies before and after the crisis (in $million)**

<table>
<thead>
<tr>
<th></th>
<th>Finance</th>
<th>Non Finance</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEFORE CRISIS</td>
<td>1.627.07</td>
<td>2.677.94</td>
</tr>
<tr>
<td>AFTER CRISIS</td>
<td>1.647.71</td>
<td>2.719.90</td>
</tr>
</tbody>
</table>

**Ratio of average value of implicit government guarantee over the Market value for finance and non-finance companies before and after the crisis**

<table>
<thead>
<tr>
<th></th>
<th>Finance</th>
<th>Non Finance</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEFORE CRISIS</td>
<td>0.14%</td>
<td>0.12%</td>
</tr>
<tr>
<td>AFTER CRISIS</td>
<td>1.92%</td>
<td>0.90%</td>
</tr>
</tbody>
</table>
Table 1: Summary statistics for bailed out and bankrupt firms from 2000 to 2015

Panel A. Distribution of bankrupt and bailed out firms by industry

<table>
<thead>
<tr>
<th></th>
<th>Non-Finance</th>
<th>Finance</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bankrupt</td>
<td>1072</td>
<td>175</td>
<td>1247</td>
</tr>
<tr>
<td>Row Pct</td>
<td>85.97%</td>
<td>14.03%</td>
<td></td>
</tr>
<tr>
<td>Col Pct</td>
<td>98.17%</td>
<td>36.53%</td>
<td>79.38%</td>
</tr>
<tr>
<td>Bailout</td>
<td>20</td>
<td>304</td>
<td>324</td>
</tr>
<tr>
<td>Row Pct</td>
<td>6.17%</td>
<td>93.83%</td>
<td></td>
</tr>
<tr>
<td>Col Pct</td>
<td>1.83%</td>
<td>63.47%</td>
<td>20.62%</td>
</tr>
<tr>
<td>Total</td>
<td>1092</td>
<td>479</td>
<td>1571</td>
</tr>
<tr>
<td></td>
<td>69.51%</td>
<td>30.49%</td>
<td></td>
</tr>
</tbody>
</table>

Panel B. Summary statistics for variables used in the estimation of the government guarantee

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dum_Bailout</td>
<td>1571</td>
<td>0.206</td>
<td>0.405</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Dum_Finance</td>
<td>1571</td>
<td>0.305</td>
<td>0.461</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Assets ($million)</td>
<td>1545</td>
<td>12,065.78</td>
<td>103,75</td>
<td>32.5</td>
<td>2,100,385</td>
</tr>
<tr>
<td>lgasset</td>
<td>1545</td>
<td>6.79</td>
<td>1.529</td>
<td>3.481</td>
<td>14.558</td>
</tr>
</tbody>
</table>

Panel C. Correlation coefficients

<table>
<thead>
<tr>
<th></th>
<th>Bailout</th>
<th>Finance Industry</th>
<th>lgasset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dum_Bailout</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dum_Finance</td>
<td>0.6854***</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>lgasset</td>
<td>0.36***</td>
<td>0.397***</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: Dum_Bailout is the dummy variable taking the value of 1 if the firm is bailed out, and 0 otherwise. Dum_Finance is the dummy variable taking the value of 1 for finance firms, and 0 for non-finance firms. Lgasset is the natural logarithm of the total assets of the firm.

*** p<0.01, ** p<0.05, * p<0.1.
Table 2: Logit regression for the estimation of the probability of the government intervention using the sample of bailed out and bankrupt firms from 2000 to 2015. This table shows parameter estimates of the logit regression of the probability of the government intervention. The sample includes 1571 bankrupt and bailed out companies between 2000 and 2015. Dum_finance indicates whether or not the firm belongs to the finance industry. Igasset is the natural log of the total assets.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dum_Finance</td>
<td>4.534***</td>
<td>4.676***</td>
<td>9.101***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.245]</td>
<td>[0.299]</td>
<td>[1.438]</td>
<td></td>
</tr>
<tr>
<td>Igasset</td>
<td>0.546***</td>
<td>0.214***</td>
<td>0.766***</td>
<td>-0.606***</td>
</tr>
<tr>
<td></td>
<td>[0.0449]</td>
<td>[0.056]</td>
<td>[0.170]</td>
<td>[0.179]</td>
</tr>
<tr>
<td>Igasset*Dum_Finance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-3.982***</td>
<td>-5.307***</td>
<td>-5.814***</td>
<td>-9.833***</td>
</tr>
<tr>
<td></td>
<td>[0.226]</td>
<td>[0.335]</td>
<td>[0.471]</td>
<td>[1.370]</td>
</tr>
<tr>
<td>AIC</td>
<td>832.494</td>
<td>1342.16</td>
<td>742.288</td>
<td>733.667</td>
</tr>
<tr>
<td>Pseudo R2</td>
<td>0.607</td>
<td>0.173</td>
<td>0.634</td>
<td>0.640</td>
</tr>
<tr>
<td>Observations</td>
<td>1571</td>
<td>1545</td>
<td>1545</td>
<td>1545</td>
</tr>
</tbody>
</table>

Note: Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.
Table 3: Summary Statistics of Company Level Estimates Data and Funding Cost Variables (from 2000 – 2015). This table provides summary statistics for listed firms, BHCs, and FDIC banks. Vg is the value of the contingent claim. Pi is the probability of the government bailout. Evg is the expected value of the implicit government guarantee. Leverage is the ratio of the total debt to the total assets. Funding cost is the ratio of the total interest expenses to the average total interest bearing liabilities. Panel A presents the descriptive statistics of firms’ fundamentals and estimated government guarantee variables. Panel B presents the descriptive statistics of fundamentals and funding cost variable for BHCs. Panel C presents the descriptive statistics of fundamentals and funding cost variable for FDIC banks.

Panel A: Descriptive Statistics of Variables for Government Guarantee Estimated

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>Median</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Value ($million)</td>
<td>307,464</td>
<td>2,829</td>
<td>280</td>
<td>13,926</td>
<td>2.2</td>
<td>723,725</td>
</tr>
<tr>
<td>Total asset ($million)</td>
<td>307,464</td>
<td>11,347</td>
<td>554</td>
<td>94,336</td>
<td>10</td>
<td>3,879,170</td>
</tr>
<tr>
<td>Total liabilities ($million)</td>
<td>307,116</td>
<td>9,279</td>
<td>286</td>
<td>87,986</td>
<td>5.3</td>
<td>3,672,760</td>
</tr>
<tr>
<td>Vg ($million)</td>
<td>147,078</td>
<td>23.68</td>
<td>0</td>
<td>864.87</td>
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<td>111,220</td>
</tr>
<tr>
<td>$\pi_i$</td>
<td>307,464</td>
<td>0.15</td>
<td>0.01</td>
<td>0.25</td>
<td>0</td>
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<tr>
<td>Evg ($million)</td>
<td>147,075</td>
<td>12.91</td>
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Panel B: Descriptive Statistics of BHC Level Data

<table>
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<th>Median</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total asset ($million)</td>
<td>3450</td>
<td>129,744</td>
<td>27,067</td>
<td>349,629</td>
<td>28.8</td>
<td>2,577,148</td>
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<tr>
<td>Total debt ($million)</td>
<td>3450</td>
<td>29,986</td>
<td>4,002</td>
<td>95,863</td>
<td>0.7</td>
<td>873,301</td>
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<tr>
<td>Total liabilities ($million)</td>
<td>3450</td>
<td>117,363</td>
<td>24,122</td>
<td>316,495</td>
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<td>2,341,284</td>
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<tr>
<td>Leverage</td>
<td>3450</td>
<td>17.12%</td>
<td>16.67%</td>
<td>8.38%</td>
<td>0.26%</td>
<td>51.15%</td>
</tr>
<tr>
<td>Funding Cost</td>
<td>3450</td>
<td>2.05%</td>
<td>1.76%</td>
<td>1.54%</td>
<td>0.02%</td>
<td>10.49%</td>
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Panel C: Descriptive Statistics of FDIC Depository Level Data.

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<th>Median</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total asset ($million)</td>
<td>523,063</td>
<td>1,446</td>
<td>129</td>
<td>26,760</td>
<td>0.1</td>
<td>2,096,114</td>
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<tr>
<td>Total liabilities ($million)</td>
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<td>1,295</td>
<td>115</td>
<td>24,183</td>
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<td>1,905,556</td>
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<td>2.38%</td>
<td>2.19%</td>
<td>1.46%</td>
<td>0.07%</td>
<td>8.48%</td>
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<table>
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<th>Variable</th>
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<th>Median</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vg ($million)</td>
<td>24.518</td>
<td>11.793</td>
<td>20.420</td>
<td>0.376</td>
<td>86.968</td>
</tr>
<tr>
<td>(\pi_i)</td>
<td>0.153</td>
<td>0.155</td>
<td>0.017</td>
<td>0.045</td>
<td>0.177</td>
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<tr>
<td>Evg ($million)</td>
<td>13.376</td>
<td>4.065</td>
<td>14.769</td>
<td>0.0005</td>
<td>62.984</td>
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Panel B: Descriptive Statistics of Time-Series Variables Used for Regression Related to BHC Level

<table>
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<th>Variable</th>
<th>Mean</th>
<th>Median</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
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<tbody>
<tr>
<td>FCostLarge</td>
<td>1.71%</td>
<td>1.49%</td>
<td>1.36%</td>
<td>0.21%</td>
<td>4.76%</td>
</tr>
<tr>
<td>FCostSmall</td>
<td>1.68%</td>
<td>1.50%</td>
<td>1.26%</td>
<td>0.21%</td>
<td>4.57%</td>
</tr>
<tr>
<td>FCostDiff</td>
<td>-0.03%</td>
<td>0.01%</td>
<td>0.16%</td>
<td>-0.33%</td>
<td>0.25%</td>
</tr>
<tr>
<td>SizeLarge ($ billion)</td>
<td>171.38</td>
<td>144.40</td>
<td>85.09</td>
<td>84.07</td>
<td>376.14</td>
</tr>
<tr>
<td>SizeSmall ($ billion)</td>
<td>15.46</td>
<td>13.95</td>
<td>4.95</td>
<td>9.49</td>
<td>26.96</td>
</tr>
<tr>
<td>SizeDiff ($ billion)</td>
<td>155.92</td>
<td>130.03</td>
<td>80.59</td>
<td>73.88</td>
<td>349.18</td>
</tr>
<tr>
<td>LevLarge</td>
<td>18.78%</td>
<td>20.65%</td>
<td>4.99%</td>
<td>10.31%</td>
<td>26.20%</td>
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<tr>
<td>LevSmall</td>
<td>14.33%</td>
<td>16.39%</td>
<td>3.64%</td>
<td>7.76%</td>
<td>19.05%</td>
</tr>
<tr>
<td>LevDiff</td>
<td>-4.45%</td>
<td>-4.10%</td>
<td>2.21%</td>
<td>-9.27%</td>
<td>0.30%</td>
</tr>
<tr>
<td>GDP Growth</td>
<td>1.81%</td>
<td>2.20%</td>
<td>2.46%</td>
<td>-8.20%</td>
<td>6.90%</td>
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Panel C: Descriptive Statistics of Time-Series Variables Used for Regression Related to FDIC Depository Level

<table>
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<th>Mean</th>
<th>Median</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCostLarge</td>
<td>1.68%</td>
<td>1.36%</td>
<td>1.36%</td>
<td>0.19%</td>
<td>4.61%</td>
</tr>
<tr>
<td>FCostSmall</td>
<td>2.10%</td>
<td>2.04%</td>
<td>1.26%</td>
<td>0.49%</td>
<td>4.95%</td>
</tr>
<tr>
<td>FCostDiff</td>
<td>0.42%</td>
<td>0.46%</td>
<td>0.37%</td>
<td>-0.47%</td>
<td>1.11%</td>
</tr>
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<td>SizeLarge ($ billion)</td>
<td>150.26</td>
<td>151.15</td>
<td>39.92</td>
<td>90.46</td>
<td>223.01</td>
</tr>
<tr>
<td>SizeSmall ($ billion)</td>
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<td>0.14</td>
<td>0.03</td>
<td>0.09</td>
<td>0.19</td>
</tr>
<tr>
<td>SizeDiff ($ billion)</td>
<td>150.12</td>
<td>151.02</td>
<td>39.89</td>
<td>90.37</td>
<td>222.82</td>
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Table 5: Correlations between Time-Series Variables Used for Regression

Panel A: Time-Series Variables Used for Regression Related to BHC Level

<table>
<thead>
<tr>
<th></th>
<th>Evg</th>
<th>FCostLarge</th>
<th>FCostSmall</th>
<th>FCostDiff</th>
<th>SizeLarge</th>
<th>SizeSmall</th>
<th>SizeDiff</th>
<th>LevLarge</th>
<th>LevSmall</th>
<th>LevDiff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evg</td>
<td>1.000</td>
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<td></td>
</tr>
<tr>
<td>FCostLarge</td>
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</tr>
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<td>FCostDiff</td>
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<td>-0.5938</td>
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<td>SizeLarge</td>
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<td>-0.5500</td>
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<tr>
<td>SizeSmall</td>
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<td>0.1918</td>
<td>0.9145</td>
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<td>0.9997</td>
<td>0.9042</td>
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</tr>
<tr>
<td>LevLarge</td>
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<td>-0.6426</td>
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<td>LevSmall</td>
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<td>0.7455</td>
<td>-0.4457</td>
<td>-0.6027</td>
<td>-0.7796</td>
<td>-0.5885</td>
<td>0.9153</td>
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</tr>
<tr>
<td>LevDiff</td>
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<td>-0.5615</td>
<td>0.3290</td>
<td>0.4564</td>
<td>0.5642</td>
<td>0.4473</td>
<td>-0.7475</td>
<td>-0.4166</td>
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Panel B: Time-Series Variables Used for Regression Related to FDIC Depository Level

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<thead>
<tr>
<th></th>
<th>Evg</th>
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<th>FCostSmall</th>
<th>FCostDiff</th>
<th>SizeLarge</th>
<th>SizeSmall</th>
<th>SizeDiff</th>
<th>GDP Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evg</td>
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<td>FCostSmall</td>
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</tr>
<tr>
<td>SizeLarge</td>
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<td>-0.6811</td>
<td>-0.7376</td>
<td>0.0047</td>
<td>1.0000</td>
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</tr>
<tr>
<td>SizeSmall</td>
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<td>-0.7271</td>
<td>-0.7789</td>
<td>0.0342</td>
<td>0.9825</td>
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<tr>
<td>SizeDiff</td>
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<td>-0.6810</td>
<td>-0.7376</td>
<td>0.0047</td>
<td>1.0000</td>
<td>0.9825</td>
<td>1.0000</td>
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</tr>
<tr>
<td>GDP Growth</td>
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<td>-0.1905</td>
<td>-0.2390</td>
<td>-0.1101</td>
<td>-0.0717</td>
<td>-0.0631</td>
<td>-0.0717</td>
<td>1.0000</td>
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</table>
Table 6: Implicit Government Guarantee in relation with BHC Funding Cost for Large and Small Banks, Size, Leverage, and GDP Growth. For funding cost, size and leverage, models below show the relationship between their averages and the average value of the government guarantee, which represent the expected value of the put option enjoyed by a firm under the *implicit* government guarantee. Independent factors are built here using data at the BHC Level from Compustat. All variables are quarterly form 2000 Q1 to 2015 Q4.

<table>
<thead>
<tr>
<th>Model</th>
<th>FCostLarge</th>
<th>FCostSmall</th>
<th>SizeLarge</th>
<th>SizeSmall</th>
<th>LevLarge</th>
<th>LevSmall</th>
<th>GDP Growth</th>
<th>Constant</th>
<th>R-squared</th>
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<td>-744.023***</td>
<td>-783.273***</td>
<td>0.053***</td>
<td>1.4048***</td>
<td>-238.083***</td>
<td>-333.166***</td>
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<td>26.239***</td>
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<td>Model 2</td>
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<td>26.753***</td>
<td>0.439</td>
</tr>
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<td>Model 3</td>
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<td>[9.43]</td>
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<td>[10.70]</td>
<td>[11.24]</td>
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</tbody>
</table>

Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%
Table 7: Implicit Government Guarantee in relation with BHC Funding Cost Difference between Large and Small Banks, Size, Leverage, and GDP Growth. For funding cost, size and leverage, models below show the relationship between their averages and the average value of the government guarantee, which represent the expected value of the put option enjoyed by a firm under the *implicit* government guarantee. Independent factors are built here using data at the BHC Level from Compustat. A parameter for a variable with suffix “Aft” represents the change after the crisis. All variables are quarterly form 2000 Q1 to 2015 Q4.

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCostDiff</td>
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<td>2,357.347***</td>
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<tr>
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<td>[5.77]</td>
<td>[3.27]</td>
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<tr>
<td>AfterCrisis×FCostDiff</td>
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<td>[3.57]</td>
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</tr>
<tr>
<td>SizeDiff</td>
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<td>0.0532***</td>
<td>-0.151***</td>
<td></td>
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</tr>
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<td>[3.58]</td>
<td>[3.70]</td>
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</tr>
<tr>
<td>AfterCrisis×SizeDiff</td>
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<td>0.162***</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>[6.00]</td>
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<td></td>
</tr>
<tr>
<td>LevDiff</td>
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<td></td>
<td>325.379***</td>
<td>205.514***</td>
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</tr>
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<td>[3.64]</td>
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</tr>
<tr>
<td>AfterCrisis×LevDiff</td>
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<td>-563.224***</td>
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<td>[6.87]</td>
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</tr>
<tr>
<td>GDP Growth</td>
<td>77.541</td>
<td>65.089</td>
<td>63.752</td>
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<td>109.939*</td>
<td>60.720*</td>
</tr>
<tr>
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<td>[1.41]</td>
<td>[1.62]</td>
<td>[1.20]</td>
<td>[0.24]</td>
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<td>[1.12]</td>
<td>[4.52]</td>
<td>[6.91]</td>
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<td>R-squared</td>
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<td>0.099</td>
<td>0.542</td>
<td>0.248</td>
<td>0.655</td>
</tr>
</tbody>
</table>

Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%
Table 8: Implicit Government Guarantee in relation with FDIC Funding Cost for Large and Small Banks, Size, and GDP Growth. For funding cost, size and leverage, models below show the relationship between their averages and the average value of the government guarantee, which represent the expected value of the put option enjoyed by a firm under the implicit government guarantee. Independent factors are built here using data at the Depository Level from FDIC. All variables are quarterly form 2000 Q1 to 2015 Q4.

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCostLarge</td>
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</tr>
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Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%
Table 9: Implicit Government Guarantee in relation with FDIC Funding Cost Difference between Large and Small Banks, Size, and GDP Growth. For funding cost, size and leverage, models below show the relationship between their averages and the average value of the government guarantee, which represent the expected value of the put option enjoyed by a firm under the *implicit* government guarantee. Independent factors are built here using data at the Depository Level from FDIC. A parameter for a variable with suffix “Aft” represents the change after the crisis. All variables are quarterly form 2000 Q1 to 2015 Q4.

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</table>

Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%
Online Appendix: Robustness Check Using an Alternative Definition of Large Banks (total assets above $100 billion)

Online Appendix: Robustness Check Using an Alternative Definition of Large Banks

For results from Tables R1-R4, instead of defining large banks as the top 20 banks in each quarter, we use Baker and McArthur (2009) definition, for which large banks are those with more than $100 billion in total assets.

Table R1: Implicit Government Guarantee in relation with BHC Funding Cost for Large and Small Banks, Size, Leverage, and GDP Growth. For funding cost, size and leverage, models below show the relationship between their averages and the average value of the government guarantee, which represent the expected value of the put option enjoyed by a firm under the implicit government guarantee. Independent factors are built here using data at the BHC Level from Compustat. All variables are quarterly form 2000 Q1 to 2015 Q4.

<table>
<thead>
<tr>
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R-squared 0.455 0.441 0.109 0.425 0.575 0.6527

Robust t statistics in brackets

* significant at 10%; ** significant at 5%; *** significant at 1%
Table R2: Implicit Government Guarantee in relation with BHC Funding Cost Difference between Large and Small Banks, Size, Leverage, and GDP Growth. For funding cost, size and leverage, models below show the relationship between their averages and the average value of the government guarantee, which represent the expected value of the put option enjoyed by a firm under the implicit government guarantee. Independent factors are built here using data at the BHC Level from Compustat. Parameters for variables with suffix “Aft” represents the change after the crisis. All variables are quarterly form 2000 Q1 to 2015 Q4.

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Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%
Table R3: Implicit Government Guarantee in relation with FDIC Funding Cost for Large and Small Banks, Size, and GDP Growth. For funding cost, size and leverage, models below show the relationship between their averages and the average value of the government guarantee, which represent the expected value of the put option enjoyed by a firm under the implicit government guarantee. Independent factors are built here using data at the Depository Level from FDIC. All variables are quarterly form 2000 Q1 to 2015 Q4.

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<td></td>
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<td>340.840***</td>
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Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%
Table R4: Implicit Government Guarantee in relation with FDIC Funding Cost Difference between Large and Small Banks, Size, and GDP Growth. For funding cost, size and leverage, models below show the relationship between their averages and the average value of the government guarantee, which represent the expected value of the put option enjoyed by a firm under the implicit government guarantee. Independent factors are built here using data at the Depository Level from FDIC. Parameters for variables with suffix “Aft” represents the change after the crisis. All variables are quarterly form 2000 Q1 to 2015 Q4.

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Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%