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HOW MUCH WOULD IT COST TO GUARANTEE DEBT FOR ALL PUBLICLY TRADED US CORPORATIONS?

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ABSTRACT

Estimated marked-to-market values of guaranteeing debt ex ante for all available publicly traded US corporations from fourth quarter (Q4) 1971 to Q4 2022 reveal that the highest estimates periodically arise with a handful of large financial corporations, but nonfinancial corporations can also have significant estimates. The real Q1 2010 estimated cost peaks at $983 billion in Q1 2009 and $284.78 billion in Q1 2020 during the COVID-19 pandemic. Debt guarantees may reflect moral hazard but also concerns about avoiding substantial increases in unemployment or maintaining the provision of essential services during national emergencies. Leverage restrictions could limit actual debt guarantees.

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DISCLAIMER

How Much Would It Cost to Guarantee Debt for All Publicly Traded US Corporations?

1. Introduction

The term *too big to fail* (TBTF) tends to apply to banks that experience distress, such as Continental Illinois in 1984 (see Strahan 2013). In contrast, the term *government bailout* tends to apply to large nonfinancial corporations that experience distress, such as the Penn Central Railroad in 1976, the Chrysler Corporation in 1979, and airlines after September 11, 2001 (see Leathers and Raines 2003). In either case, corporate distress may result in the government guaranteeing debt to protect the corporation from default instead of allowing it to go through bankruptcy proceedings. In this paper, I provide option theory–based estimates of marked-to-market values of the cost to insure debt for all available corporations with publicly traded shares in the United States from fourth quarter (Q4) 1971 to Q4 2022. These estimates measure the ex ante cost of returning a corporation to solvency should it fail during the next year (see Snethlage 2015 and Grimaldi et al. 2016). Then I use the corporation-specific estimated costs of guaranteeing that debt to provide industry-specific and aggregate estimates. Given that large financial and nonfinancial corporations in industries with the highest estimated cost of guaranteeing debt tend to be highly leveraged, one way to limit budget impacts of actual debt guarantees could be to impose maximum leverage restrictions on likely recipients.

The theoretical motivation for this exercise comes from Merton (1974, 1977). Merton (1974) applies the Black and Scholes (1973) and Merton (1973) option-pricing framework to show, among other things, the isomorphic relationship between a firm's equity and a call option on a firm's assets for the case where the firm pays no dividends. Merton (1977) also shows the isomorphic relationship between debt guarantees, such as deposit insurance, and a put option on a firm's assets, again for the case where the firm pays no dividends. Draghi, Giavazzi, and Merton (2003) and Gray and Malone (2008) show how to incorporate private-sector guarantees estimated as in Merton (1977) in macrofinancial risk analysis.

To estimate the value of such guarantees, Ronn and Verma (1986) propose a two-step approach based on the contingent claims analysis in Merton (1974, 1977), which Duan and Wang (2012) call the volatility restriction method. In the first step, the method calls for using a derived restriction between equity and asset volatility together with the call option formula to obtain estimates of unobserved market values of assets and asset volatility simultaneously. The second step involves substituting the estimated asset values and asset volatility into the put option formula to compute put option values, which measure the value of debt guarantees. I use total debt as the debt input, as in Ronn and Verma (1986). Altman and Benhenni (2019) report that the 2015–2017 average market value of debt relative to its face value equaled 35 percent for defaulted public debt and 65 percent for distressed public debt; for private debt the averages were higher. The data I use include only corporations that have survived through the end of a given quarter, such that, in most cases, they are, at worst, distressed. I therefore restrict how far the estimated market value of debt can fall relative to its face value, as proxied by book value, at either 0.65 or, alternatively, 0.8, with the latter generating lower-bound baseline estimates reported here. I also assume corporations pay no dividends and buy back no shares, but I get similar results if I adjust for dividends or the payout ratio, computed as the sum of dividends and share buybacks.

When aggregated across all corporations in the sample, the mean/median aggregate quarterly cost of guaranteeing debt equals $29.8/$6.02 billion. The peak value of the estimated cost during the 2007–2009 financial crisis arose in Q1 2009 and equaled $983 billion, equivalent to 6.6 percent of GDP. In Q1 2020, at the start of the COVID-19 pandemic, the aggregate estimated cost equaled $284.78 billion, equivalent to 1.6 percent of GDP. In Q4 1998, after the Russian default, the aggregate estimated cost equaled $190.41 billion, also equivalent to 1.6 percent of GDP.

The empirical exercise here relates to research on credit risk, including that provided by the credit risk industry to investors, but rather than default probabilities, I focus on the dollar value of distress, which can have government budget implications. The exercise here also relates to the recent debate over whether the TBTF problem has been addressed since the 2007–2009 financial crisis (see Sarin and Summers 2016; Atkenson et al. 2018; Berndte, Duffie, and Zhu 2022). The results suggest that the TBTF–bailout problem has not been eliminated but, instead, appears to be a short-lived, though recurring, problem during periods of widespread economic distress and can exist for nonfinancial corporations as well.

The ratio of the estimated value of guaranteeing debt ex ante to the market value of equity sometimes serves as an estimate of the size of shareholder subsidies (e.g., Milne 2014). The results suggest that telecommunication services, media and entertainment, banks, and financial services (including investment banks) have the four highest industry averages, equal to only 0.13, 0.11, 0.1, and 0.08, respectively, whereas the average across all industries during the sample equals only 0.04. In contrast to the industry medians, which equal zero, the average results reflect extreme values within industries, especially during periods of distress. Bearing in mind that a positive estimate does not indicate that a corporation will actually benefit from government assistance, of the top 100 estimated quarterly guarantees, banks had 54, diversified financials had 24, and insurance companies had 7; 15 of the top 100 estimated guarantees arise with nonfinancial corporations.

The TBTF bailout problem exists for several posited reasons. First and foremost is moral hazard in that bailout expectations may create incentives for more corporate risk-taking (Strahan 2013). Studies also find a link between corporations, especially financial corporations, with political connections and bailouts (see Faccio, Masulis, and McConnell 2006; Duchin and Sosyura 2012; Igan, Mishra, and Tressel 2012; Blau, Brough, and Thomas 2013; Vukovic 2021). However, the government may, rightly or wrongly, have other reasons to assist distressed corporations. For instance, debt guarantees might stabilize the provision of goods or services that are deemed part of some social contract or might prevent sudden increases in unemployment owing to a large corporation's potential failure (Ho and Singer 1982; Azgad-Tromer 2017; Rockoff 2022). Empirically, I find the estimated ex ante cost of guaranteeing debt is correlated with employment, whereby the largest estimated costs during periods of distress arise with corporations that tend to employ a large number of people. The quarterly average number of employees for corporations in the lower 19 ventiles during the sample ranged from 4,700 to 14,300, whereas the quarterly average number of employees for corporations in the 20th ventile during the sample ranged from 2,160 to 35,710 people. During the 2007–2009 financial crisis, the average number of employees for corporations in the 20th ventile of estimated ex ante costs peaked in Q4 2008 at 34,860, whereas the average for all other ventiles equaled 8,920. In Q1 2020, as the economic effects of the COVID-19 pandemic began to materialize, the average number of employees for corporations in the 20th ventile of estimated ex ante costs equaled 35,710, whereas the average for the lower ventiles equaled 10,980. In addition, some corporations that experience distress may also contribute to the provision of goods and services during national emergencies, such as wars, pandemics, and various financial crises. Policymakers may justify taking measures to keep such corporations alive to maintain existing capacity, even if the corporations are unprofitable. That is not to say that policymakers should do that, but also to the extent that they do, one way to reduce the likelihood of insolvency ex ante and any impact on the government's budget owing to guarantees could be through leverage restrictions, given that high leverage, rather than asset volatility, is often the source of distress. I describe the methodology and data before summarizing the aggregate results and the industry- and corporation-specific results before concluding.

2. Public Debt Guarantees and the Valuation of Debt Guarantees as a Put Option

Government debt guarantees often receive considerable public scrutiny, leading to subsequent legislation. For instance, when the Chrysler Corporation experienced financial difficulties in 1979 and lobbied for government assistance, Congress sought concessions for the loan guarantees through the Chrysler Corporation Loan Guarantee Act of 1979 (Pub. L. No. 96-185, 93 Stat. 1324). After the Continental Illinois failure in May 1984 (see Rockoff 2022), Congress sought to limit bank debt guarantees through the Federal Deposit Insurance Corporation Improvement Act of 1991 (Pub. L. No. 102-242, 105 Stat. 2236).[1] Congress sought again to limit them after the 2007–2009 financial crisis through the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 (Pub. L. No. 111-203, 124 Stat. 1376), which states as its objective:

> To promote the financial stability of the United States by improving accountability and transparency in the financial system, to end "too big to fail," to protect the American taxpayer by ending bailouts, to protect consumers from abusive financial services practices, and for other purposes.[2]

Despite political declarations and legislative efforts, concerns over TBTF bailouts remain.[3]

To estimate ex ante costs of guaranteeing debt for all available noncommercial bank corporations with traded shares in a given quarter, I use total debt as the debt input.[4] For commercial banks, I use total deposits as the debt input as in Ronn and Verma (1986), given that Black (1975) suggests the government would ultimately guarantee all deposits; an example of that arose in the aftermath of the recent bank failures in spring 2023, when regulators guaranteed all deposits (see, for instance, Federal Deposit Insurance Corporation 2023). The approach follows Merton's (1974, 1977) contingent claims analysis to value debt guarantees.[5] Merton (1974) shows the isomorphic relationship between equity and a call option on a theoretical firm's assets, while

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[1] See Federal Reserve History (2023). During a congressional hearing concerning Continental Illinois, Stewart McKinney, a representative from Connecticut, stated: "We have [created] a new kind of bank. It is called too big to fail. TBTF, and it is a wonderful bank."

[2] See Dodd-Frank Wall Street Reform and Consumer Protection Act, H.R. 4173, 111th Cong. (2010). https://www.congress.gov/bill/111th-congress/house-bill/4173/text.

[3] For a statement that the Dodd-Frank Act would end TBTF, see Lee (2010). See also the subsequent initiative at the Federal Reserve Bank of Minneapolis to address the post-Dodd-Frank Minneapolis Fed Plan to end TBTF at https://www.minneapolisfed.org/policy/endingtbtf.

[4] Stephen Kealhofer, John McQuown, and Oldrich Vasicek's (KMV) industry standard approach (currently owned by Moody's) would provide an alternative debt input for this exercise, which assumes the default point occurs when the market value of assets equals the sum of short-term debt and one-half of long-term debt. However, I assume distressed corporations, rather than corporations in default, get their debt guaranteed, and, therefore, I focus on how the estimated market value of total debt falls relative to its face value.

[5] Marcus and Shaked (1984) suggest an approach like that of Ronn and Verma (1986). Milne (2014) also applies Ronn and Verma's (1986) approach to examine the value of TBTF subsidies among large global banks during the 2007–2009 financial crisis but uses the KMV measure of debt.

Merton (1977) shows the isomorphic relationship between a debt guarantee and a put option on that firm's assets.

In estimating the debt guarantees, I make use of Altman and Benhenni's (2019) finding that in 2015–2017, for distressed corporations, as opposed to corporations in default, the ratio of the market value of debt relative to its face value, as proxied by book value, equaled 65 percent; in the baseline lower-bound case, I assume the ratio equals at least 80 percent. That implies that the estimated market value of assets can fall no lower than 0.65*[book debt] plus market equity or, in the baseline case, no lower than 0.8*[book debt] plus market equity.[6] I also compare estimates that do not adjust for share buybacks and dividends with estimates that do adjust, but I get similar results. By using a derived restriction on the theoretical relationship between equity and asset volatility, the method simultaneously solves for the value and volatility of a firm's assets, which are unobservable outside the firm. These estimates then serve as inputs to value the corresponding debt guarantee, which I discuss next.

Merton (1974) substitutes the market value of assets for the stock price and debt for the strike price in the Black-Scholes formula, which for a stock paying dividends continuously yields:

$$E = Call(A, D, q, r, \sigma_A, T - t) \tag{1}$$

$$= Ae^{-q(T-t)}N(d_1) - De^{-r(T-t)}N(d_2),$$

$$d_1 = \frac{ln\left(\frac{A}{D}\right) + \left(r - q + \frac{\sigma_A^2}{2}\right)(T-t)}{\sigma_A\sqrt{T-t}} \text{ and } d_2 = d_1 - \sigma_A\sqrt{T-t},$$

where E denotes the market value of equity; A denotes the market value of the firm's total assets; q denotes the ratio of dividends or the payout, the sum of dividends and share buybacks, relative to total assets; $N(\cdot)$ denotes the cumulative normal distribution function; D denotes the face value of the firm's debt; r denotes the risk-free rate of interest; σ_A denotes the volatility input of the firm's assets; t denotes the current time period; and T denotes the terminal date of the debt guarantee. Ceteris paribus, adjusting the debt guarantee estimates for the dividend yield on assets or the payout ratio generates higher debt guarantees because the difference between the asset and debt positions would be smaller, but, empirically, the differences are generally small and can be positive or occasionally negative.[7]

Given that A and σ_A in equation (1) are typically unobserved, the volatility restriction method calls for solving for A and σ_A simultaneously by using equation (1) together with a second

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[6] Define the quasi-market value of assets (QMV_A) as the sum of face value of debt (FV_D) and market equity (MV_E), or $QMV_A = FV_D + MV_E$ and the market value of assets (MV_A) as the sum of the market value of debt (MV_D) and market equity (MV_E), or $MV_A = MV_D + MV_E$. If $MV_D/FV_D = 0.65, 0.8$, then the lower bound on the market value of assets equals $0.65*FV_D + MV_E$, $0.8*FV_D + MV_E$, respectively. Using Merton's (1977) model with an added jump-diffusion component, Gudmundsson (2016) takes a similar approach by allowing the market value of assets to decline by a fixed percent k. As such, the approach here differs in that the numerical solutions determine the equivalent value of k empirically.

[7] Equation (1) can help explain the effects of the dividend yield on assets or payout ratio. It shows that their presence reduces the difference between the asset and debt positions owing to the cash flows exiting the corporation. The finance literature has pointed out that the fraction of corporations paying dividends has declined over time (see Bildik, Fatemi, and Fooladi 2015). At the same time, share buybacks have attracted attention in recent years and may have value when a corporation has no new ideas for investment; however, they can contribute to distress by making corporations more leveraged (see Aramonte 2020). As the aggregate quarterly results that adjust for share buybacks and dividends differ by no more than +$387 million/−$1 billion from the results that make no adjustments, this would suggest that share buybacks and dividends generally are not key drivers of the value debt guarantees.

equation reflecting a simple equilibrium relationship derived from Itô's lemma between the volatility of equity returns and the volatility of asset returns:

$$\sigma_E = \sigma_A \frac{\partial E}{\partial A}\frac{A}{E} \tag{2}$$

where the constant of proportionality, $\frac{\partial E}{\partial A}\frac{A}{E}$, measures the elasticity of the market value of equity to the market value of the firm's underlying assets. For a firm paying dividends continuously, $\frac{\partial E}{\partial A} = e^{-q(T-t)}N(d_1)$, which, after substituting into equation (2), yields:

$$\sigma_E = \sigma_A \frac{A}{E} e^{-q(T-t)}N(d_1). \tag{3}$$

I solve the system of two nonlinear equations, (1) and (3), in two unknowns, A and σ_A, numerically.[8] After substituting the estimates of A and σ_A, as well as D, q, r, and $T-t$, into the put-call parity condition, I can estimate the market value of a firm's debt guarantee as a put option:

$$\begin{aligned} P &= Call(A, D, q, r, \sigma_A, T-t) + De^{-r(T-t)} - Ae^{-q(T-t)} \\ &= Ae^{-q(T-t)}N(d_1) - De^{-r(T-t)}N(d_2) + De^{-r(T-t)} - A \\ &= Ae^{-q(T-t)}[N(d_1) - 1] - De^{-r(T-t)}[N(d_2) - 1] \\ &= De^{-r(T-t)}N(-d_2) - Ae^{-q(T-t)}N(-d_1). \end{aligned} \tag{4}$$

Equation (4) predicts that the debt guarantee has value when the firm has a low or negative net worth in the sense that the current value of the assets lies near or below the discounted face value of the liabilities or greater asset volatility; ceteris paribus, the greater the debt or asset volatility, the more likely it is to default.

Before turning to the estimation, I note other reasons that the estimates here likely provide lower-bound estimates. Merton (1974, 1977) follows the tradition of Black and Scholes (1973) and Merton (1973) in assuming that the dynamics of the underlying follow a geometric Brownian motion (GBM) process. Nagel and Purnanandam (2020) question this assumption for banks and provide an alternative methodology to measure default risk, inspired by the observation that fixed-income assets held by banks tend not to be modeled as a GBM process.[9] Their analysis suggests that the Merton approach may understate bank default risk in good times. However, their approach also assumes a bank cannot change its portfolios. While Merton's approach may

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[8] I estimate the unobservable market value of assets and volatility of those assets using the dtd (distance to default) function available from GitHub ("xKDR/ifrogs," https://github.com/ifrogs/ifrogs/blob/master/R/dtd.R), and described in Shah, Singh, and Aggarwal (n.d.), but I include adjustments for dividends or the payout ratio. However, I use the nlminb (nonlinear minimization subject to box constraints) function to solve the system of equations, as the optim (general-purpose optimization) function is an early nonlinear solver in *R*, and new developments to solve nonlinear equations have since been developed. (For a fuller explanation, see Nash 2016.) As starting values for the market value of assets, I use the sum of the debt input and the market value of equity, but as discussed in footnote 6, I replace the lower bound on the estimated market value of assets with the sum of 0.65*[book debt] + equity, or in the baseline case, 0.8*[book debt] + equity. For asset volatility, I use the estimated sample average asset volatility of 0.39 from an initial run because this value produces stable estimates irrespective of whether the units are in thousands, millions, or billions of US dollars.

[9] In practice, bond options may be priced with Black's (1976) variation of the Black and Scholes (1973) formula. If so, the underlying assumption in Black's approach holds that the forward price of assets, rather than the assets themselves, follows a GBM process. Moreover, the volatility input would reflect the volatility of the forward price of assets.

understate the risk and, as a result, the debt guarantee, it does not assume that banks cannot change their portfolios, as might be expected during periods of growth or distress. Also, if bank assets change over time because of growth in opportunities or increases in the value of assets (see Lucas and McDonald 2006), the GBM assumption for bank assets may, as a first approximation, characterize that growth over time, in addition to the asset volatility. Eom, Helwege, and Huang (2004) provide evidence for nonfinancial corporations that the Merton approach tends to understate bond spreads and overstate the value of investment-grade bonds, while it overstates bond spreads and understates the value of high-yield bonds.

3. Data

To form a(n) (unbalanced) panel of US corporations from Q4 1971 to Q4 2022, I use the Center for Research in Security Prices' (CRSP) CRSP–Compustat Merged (CCM) database to find quarterly financial data for all available corporations. CRSP tracks corporations listed on the New York Stock Exchange (NYSE), the American Stock Exchange, the Nasdaq, the Arca, and the Better Alternative Trading System (BATS) exchange daily, while Compustat tracks corporations that report 10-Q and 10-K filings to the Securities and Exchange Commission. The CCM database, created by CRSP, seeks to match CRSP's PERMNO/PERMCO securities/corporation identifier variables to Compustat's GVKEY corporation identifier variable.[10] The full sample includes 732,639 corporation-quarter observations, with the number of corporations ranging from 1,567 in Q4 1971 to a peak of 5,984 in Q1 1997 and back to 3,248 by Q4 2022 (see figure A1 in the appendix). Although the Compustat financial series used to estimate the guarantees are available quarterly, the employee figures are available only annually. The subsample that includes only corporations that report employee figures has 175,086 Q4 reporters and 680,016 corporation-quarter observations if the Q4 employee figures are assigned to each corporation in the three preceding intra-yearly quarters.

In the Compustat quarterly financial data, as a proxy for debt, D, for nonbank corporations, I use total debt, the sum of debt in current liabilities—short-term debt plus long-term debt expiring within one year—and long-term debt. For banks, I use total deposits. From CRSP, I compute the market value of each corporation's equity as the product of total shares outstanding and the end-of-quarter stock price, divided by 1,000, given that the shares outstanding are reported in thousands of US dollars, whereas debt is reported in millions of US dollars. As an estimate of dividends, I subtract dividends for preferred shares from cash dividends. As an estimate of buybacks, I subtract redeemable preferred shares from purchases of common and preferred stock (see Banyi, Dyl, and Kahle 2008). As an estimate of the risk-free rate of interest, r, I use quarterly returns on a 90-day US Treasury bill from CRSP. As an estimate of equity volatility, σ_E, I annualize the quarterly standard deviation of daily equity returns from CRSP data by multiplying by the square root of the product of four times the number of intraquarterly trading days, or $\sqrt{4 \cdot [trading\ days]}$. Last, I assume the time to maturity $T - t = 1$ year, as Ronn and Verma (1986) assume. Table A1 in the appendix summarizes the data used to calculate the debt guarantees. I summarize and discuss corporation-level, industry, and aggregate results next.

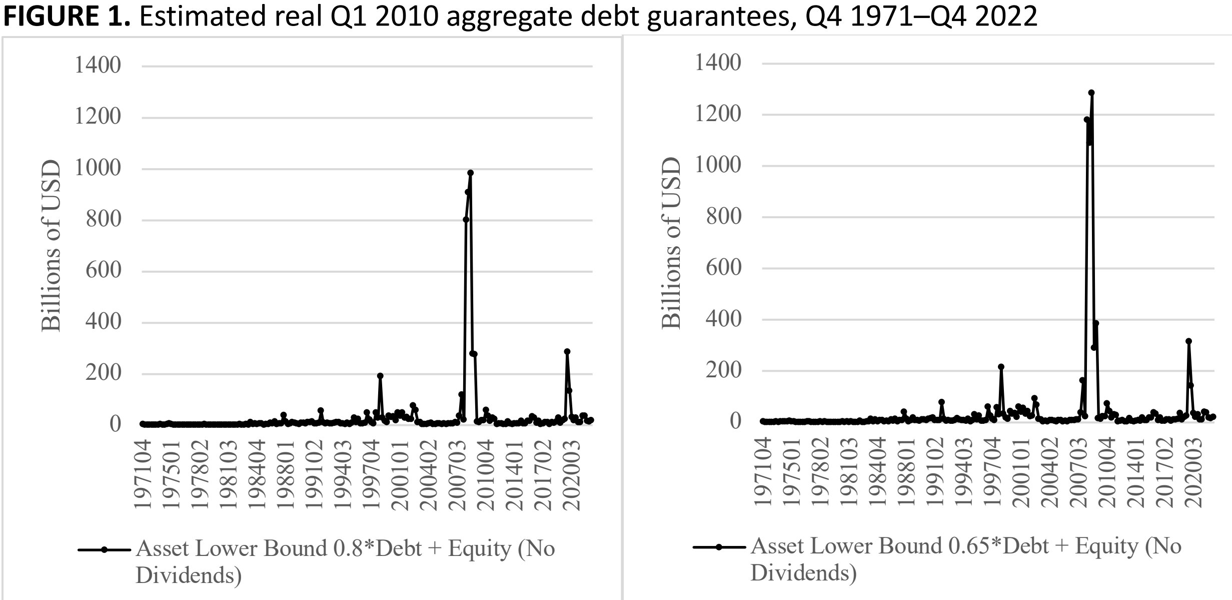
[10] PERMCO and PERMNO refer to the unique permanent identification numbers assigned by CRSP to corporations and securities, respectively, in its database. GVKEY (or Global Company Key) refers to Compustat's unique identification number for corporations.

4. Results

4.1 Estimated debt guarantees: aggregate, industry, and corporation findings

Figure 1 depicts the estimated ex ante real aggregate cost of guaranteeing debt, assuming no dividends paid or buybacks for all available corporations in each quarter from Q4 1971 to Q4 2022, using total debt and assuming that the lower bound on the market value of assets cannot fall below 0.8*debt plus market equity in the baseline case, or 0.65*debt plus market equity. I use the quarterly CRSP Consumer Price Index to generate the real Q1 2010 US dollar figures. Assuming that the lower bound on the market value of assets equals 0.8*debt/0.65*debt plus market equity, if I exclude dividends and buybacks, the sample mean and median costs equal only $29.8 billion/ $36.7 billion and $6.02 billion/$7.09 billion, respectively. Assuming the lower bound on the market value of assets equals 0.8*debt/0.65*debt plus market equity, during the 2007–2009 financial crisis, the estimated ex ante aggregate cost reaches a maximum of $983.28 billion/ $1.28 trillion in Q1 2009, with other large estimates of $800.29 billion/$1.18 trillion in Q3 2008, and $907.65 billion/$1.09 trillion in Q4 2008. During the COVID-19 pandemic in Q1 2020, estimated ex ante aggregate cost equals $284.78 billion/$314.08 billion if I assume that the estimated market value of assets cannot fall below the sum of 0.8*debt/0.65*debt plus market equity. In Q4 1998, after the Russian debt default, estimated ex ante aggregate cost equals $190.41 billion/$215.18 billion if I assume that the estimated market value of assets cannot fall below the sum of 0.8*debt/0.65*debt plus market equity, with $137 billion/$155 billion coming from Bank of America, Citigroup, and Wells Fargo. I get similar results if I adjust for dividends or dividends and buybacks.

FIGURE 1. Estimated real Q1 2010 aggregate debt guarantees, Q4 1971–Q4 2022

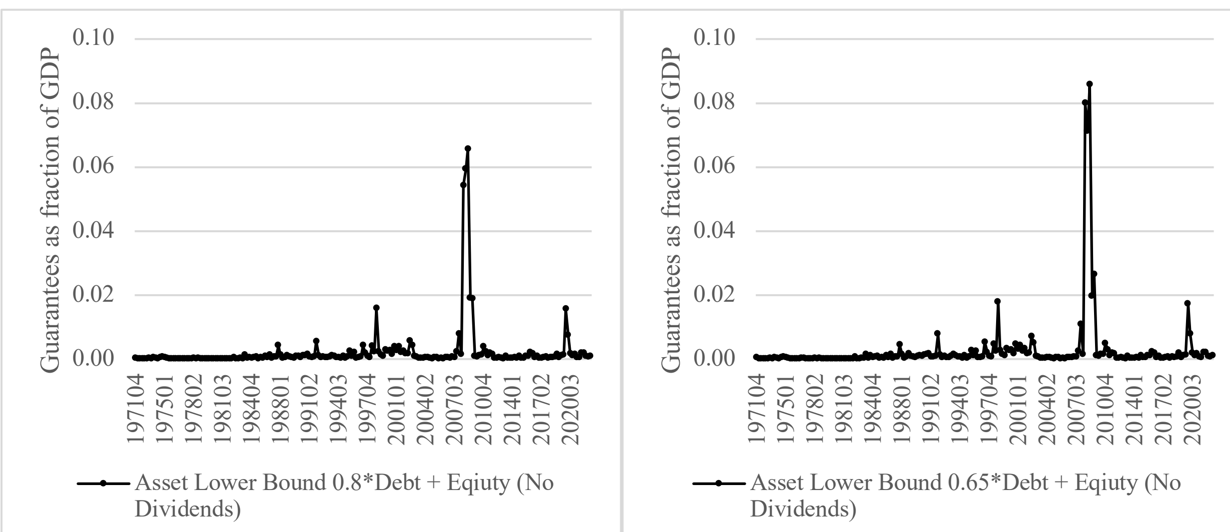


Source: Author's estimates.

Figure 2 depicts the estimated ex ante nominal cost of guaranteeing debt relative to nonseasonally adjusted nominal GDP.[11] The peak share reaches 6.6/8.6 percent in Q1 2009 when I assume the market value of assets cannot fall below the sum of 0.8*debt/0.65*debt plus market equity with no adjustments for dividends or buybacks. In Q1 2020, the estimated cost reaches 1.6/1.7 percent when I assume the estimated market value of assets cannot fall below the sum of 0.8*debt/0.65*debt plus market equity with no adjustments for dividends or buybacks. Finally, in Q4 1998, after the Russian debt default, the estimated aggregate cost of guaranteeing debt equals 1.6/1.8 percent if I assume the estimated market value of assets cannot fall below the sum of 0.8*debt/0.65*debt plus market equity. Figures 1 and 2 suggest that, while short lived, the TBTF bailout problem continues to exist, even if the source of the problem may arise with different corporations and industries over time. As the lower-bound aggregate estimates come from assuming the market value of assets cannot fall below 0.8*debt plus market equity and no dividends or buybacks, for the remaining discussion, I focus only on results generated from these assumptions.

Given concerns about financial corporations and debt guarantees, figure 3 depicts the share of the cost of guaranteeing deposits for banks or total debt for financial services corporations, assuming either that corporations pay no dividends or do not buy back shares. Throughout the sample, the average and median quarterly shares of the aggregate cost of guaranteeing debt going to banks and financial services corporations equal 28 percent and 19 percent, respectively, but figure 3 shows that out of 205 quarters, the share going to banks has exceeded 50 percent in 47 quarters and 75 percent of aggregate guarantees in 13 quarters. These findings suggest that financial corporations contribute most to the bailout problem, but one cannot ignore the problem for nonbank corporations.

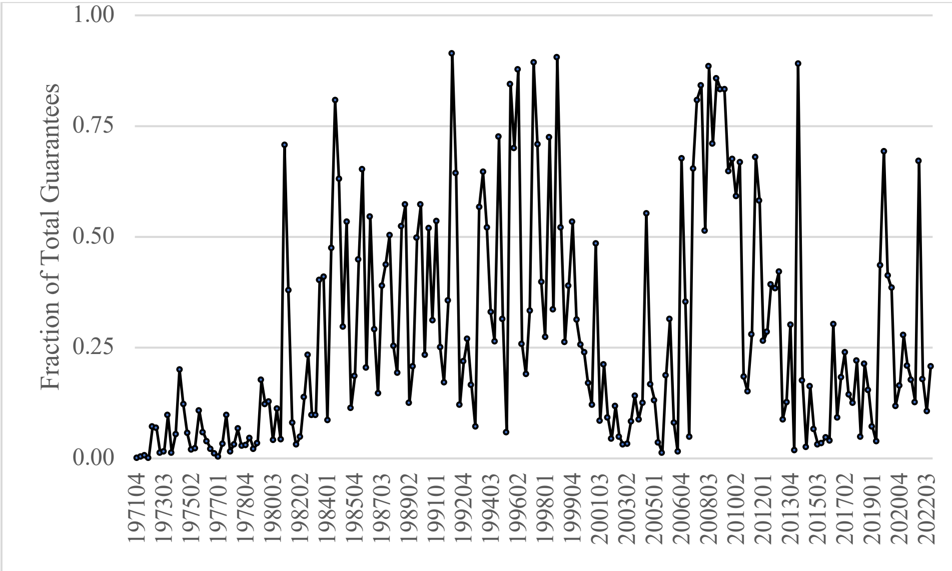
FIGURE 2. Debt guarantees as a fraction of GDP, Q4 1971–Q4 2022



Source: Author's estimates.

[11] For the nominal GDP series, in each quarter, I sum the most recent four quarters of the nonseasonally adjusted quarterly series available from the Federal Reserve Bank of St. Louis, https://fred.stlouisfed.org/series/NA000334Q.

FIGURE 3. Share of debt guarantees for banks, Q4 1971–Q4 2022



Source: Author's estimates.

To give more insight into potential subsidy rates to shareholders at the four-digit industry level, table 1 reports the industry average ratios of the estimated cost of guaranteeing debt ex ante measured relative to the market value of corporate equity (see Milne 2014). Given that the industry medians equal zero, the average ratios reflect the effects of extreme values. The table also includes the estimated asset volatility and the quasi-market leverage ratio, computed as the ratio of the market value of equity divided by the quantity of book value of assets minus book equity plus the market value of equity. The table shows that corporations in telecommunication services, in media and entertainment, in banking, and in financial services have the highest average ratios. Compared to other industries, banks have the lowest quasi-market leverage ratios, which would tend to increase the value of guarantees, but also the lowest average estimated asset volatility, which would tend to lower the value of guarantees. However, asset volatility rises during the more volatile periods, which is consistent with Nagel and Purnanandam's (2020) observation. Financial services corporations have higher average quasi-market leverage ratios but also higher asset volatility than banks do. During Q4 1998, financial services corporations, as well as corporations in 20 industry groups other than banks, on average had higher costs relative to the industry sample average of guaranteeing debt ex ante relative to equity. During Q1 2009, all industry groups on average had higher costs relative to the industry sample average of guaranteeing debt ex ante relative to equity, reflecting economy-wide increases in distress. During Q1 2020, corporations in all industry groups except semiconductors and semiconductor equipment, on average, had higher costs relative to the industry sample average of guaranteeing debt ex ante relative to equity.

TABLE 1. Four-digit sample industry average debt guarantee-to-equity ratios, asset volatility, and quasi-market leverage ratios

Industry	S&P 4-Digit Industry Codes	Sample Average Guarantee/ Mkt. Eq.	Sample Average Asset Vol.	Sample Average Mkt. Lev.	Q4 1998 Guarantee/ Mkt. Eq.	Q4 1998 Asset Vol.	Q4 1998 Mkt. Lev.	Q1 2009 Guarantee/ Mkt. Eq.	Q1 2009 Asset Vol.	Q1 2009 Mkt. Lev.	Q1 2020 Guarantee/ Mkt. Eq.	Q1 2020 Asset Vol.	Q1 2020 Mkt. Lev.
Telecommunication services	5010	0.13	0.41	0.52	0.26	0.71	0.52	0.3	0.42	0.36	3.04	0.49	0.43
Media and entertainment	5020	0.11	0.35	0.54	0.02	0.55	0.6	6.17	0.51	0.31	0.44	0.53	0.44
Banks	4010	0.10	0.06	0.12	0.06	0.1	0.16	2.06	0.12	0.07	0.15	0.12	0.1
Financial services	4020	0.08	0.31	0.42	0.34	0.54	0.41	0.87	0.6	0.36	0.21	0.52	0.39
Transportation	2030	0.06	0.3	0.45	0.09	0.46	0.47	0.93	0.43	0.32	0.28	0.5	0.43
Consumer discretionary distribution and retail	2550	0.06	0.4	0.53	0.12	0.67	0.53	0.27	0.58	0.42	0.5	0.52	0.36
Energy	1010	0.06	0.41	0.55	0.18	0.53	0.47	0.38	0.62	0.42	1.07	0.63	0.28
Consumer durables and apparel	2520	0.05	0.36	0.52	0.08	0.56	0.53	0.43	0.63	0.37	0.28	0.63	0.48
Real estate management and development	6020	0.05	0.3	0.53	0.01	0.38	0.53	0.29	0.49	0.34	0.12	0.59	0.5
Consumer services	2530	0.05	0.38	0.56	0.18	0.55	0.52	0.4	0.52	0.4	0.4	0.63	0.4
Automobiles and components	2510	0.05	0.35	0.49	0.06	0.53	0.49	1.63	0.62	0.28	0.2	0.47	0.39
Average		0.04	0.38	0.53	0.08	0.59	0.52	0.68	0.55	0.4	0.22	0.63	0.49
Healthcare equipment and services	3510	0.04	0.52	0.68	0.12	0.76	0.63	0.07	0.65	0.56	0.15	0.86	0.66

Equity real estate investment trusts	6010	0.03	0.24	0.51	0.06	0.41	0.57	0.3	0.41	0.45	0.15	0.44	0.39
Consumer staples distribution and retail	3010	0.03	0.28	0.49	0.01	0.38	0.5	0.15	0.48	0.46	0.15	0.54	0.44
Commercial and professional services	2020	0.03	0.44	0.59	0.06	0.65	0.59	0.13	0.62	0.46	0.11	0.58	0.49
Software and services	4510	0.03	0.66	0.72	0.04	1.08	0.74	0.24	0.77	0.55	0.03	0.73	0.69
Materials	1510	0.03	0.33	0.55	0.06	0.49	0.51	0.37	0.55	0.42	0.08	0.56	0.48
Capital goods	2010	0.02	0.36	0.56	0.04	0.52	0.54	0.15	0.62	0.48	0.1	0.63	0.5
Technology hardware and equipment	4520	0.02	0.55	0.67	0.04	0.83	0.66	0.11	0.77	0.48	0.04	0.69	0.6
Household and personal products	3030	0.02	0.42	0.63	0.14	0.71	0.61	0.12	0.57	0.57	0.11	0.63	0.6
Insurance	4030	0.02	0.3	0.31	0.02	0.4	0.32	0.43	0.62	0.2	0.03	0.6	0.28
Food, beverage, and tobacco	3020	0.02	0.32	0.59	0.05	0.52	0.6	0.04	0.48	0.53	0.14	0.56	0.62
Semiconductors and semiconductor equipment	4530	0.01	0.55	0.76	0.02	0.83	0.76	0.08	0.76	0.63	0.01	0.78	0.76
Pharmaceuticals, biotech, and life sciences	3520	0.01	0.66	0.8	0.02	0.98	0.8	0.08	0.92	0.65	0.03	1.07	0.77
Utilities	5510	0.01	0.15	0.38	0	0.23	0.44	0.07	0.26	0.33	0.02	0.46	0.44

Note: Mkt. Eq. = market equity; Mkt. Lev. = market leverage; S&P = Standard & Poor's; Vol. = volatility.

Table 2 lists the top 20 financial and top 20 nonfinancial corporation debt guarantees. In real terms, the largest estimated ex ante costs of guaranteeing debt arise with Bank of America, Citigroup, and Wells Fargo at the peak of the banking crisis in 2009 at $198.2 billion, $163.3 billion, and $154.9 billion, respectively. In Q3 2008, Freddie Mac and Fannie Mae had a combined real ex ante cost of guaranteeing debt equal to $287.6 billion. Wachovia's ex ante cost of guaranteeing debt is the 11th highest; given that Wachovia was acquired by Wells Fargo, one way to think about the debt guarantee is that it provides an ex ante estimate of the value provided by Wells Fargo for acquiring Wachovia's assets instead of having the government guarantee Wachovia's debt. Compare these estimates with a well-documented early commercial bank failure. Continental Illinois had the 239th-largest ex ante cost of guaranteeing debt in Q3 1984 at $2.72 billion, when the Federal Deposit Insurance Corporation (FDIC) offered "permanent assistance" on July 26, 1984, which continued until 1991 (see Federal Reserve History 2023). Thirteen of the 20 financial corporations have quasi-market leverage ratios under 5 percent, and all have values under 20 percent, which suggests that leverage is a key reason for the size of the estimated guarantees.

The estimated costs of guaranteeing debt for nonfinancial corporations are smaller than the top estimated costs of guaranteeing debt for financial corporations, but they are still considerable. The largest estimated cost of guaranteeing debt for nonfinancial corporations for Charter Communications ranks as the 42nd largest in the sample. Given the nature of its business, a corporation such as WeWork might be unlikely to get bailed out, but a number of other businesses listed could each be examples of corporations in industries that might be viewed as being crucial to national defense or to part of the social contract, whose provision of goods and services the government might want to stabilize (see Azgad-Tromer 2017). For instance, Ford, General Motors, and General Electric have traditionally contributed to national defense, and energy corporations are also often viewed as supplying products deemed important to national interests. Although no airlines appear in the top 20, there are 23 cases where the real ex ante cost of guaranteeing debt for a major carrier exceeded $1 billion. In terms of leverage and asset volatility, for nonfinancial corporations, 2 of the 20 corporations have quasi-market leverage under 5 percent, and 10 have values under 20 percent, which suggests that even for nonfinancial corporations, leverage can be the key reason for the size of the estimated guarantees.

To provide a comparison between the estimates here and official loss estimates, Lucas (2019) reports Congressional Budget Office estimates indicating that the direct fair value cost for the combined Freddie Mac and Fannie Mae bailout equaled $291 billion; the real ex ante estimates for Freddie Mac and Fannie Mae reported in nominal terms equaled $139.761 billion and $149.33 billion, respectively, for a total of $289.09 billion.

TABLE 2. Top 20 estimated debt guarantees, estimated asset volatility, and quasi-market leverage ratios for financial and nonfinancial corporations, by quarter

Company	S&P 4-Digit Industry Codes	Quarter	Real Guarantee (million)	Asset Volatility	Quasi-market Leverage Ratio under 0.2/0.05?	Company	Sector Code	Quarter	Real Guarantee (million)	Asset Volatility	Quasi-market Leverage Ratio under 0.2/0.05?
Bank of America	4010	2009-Q1	$198,248	0.30	yes/yes	Charter Communications	5020	2016-Q2	$17,893	1.26	no/no
Citigroup	4010	2009-Q3	$163,268	0.56	yes/no	Dell	4520	2019-Q1	$17,105	1.01	yes/no
Wells Fargo	4010	2009-Q1	$154,929	0.33	yes/yes	Ford	2510	2008-Q4	$15,333	0.16	yes/yes
Fannie Mae	4020	2008-Q3	$148,540	0.14	yes/yes	Pacific Gas and Electric Company	5510	2020-Q3	$12,675	1.15	yes/no
Citigroup	4010	2008-Q4	$144,164	0.30	yes/yes	General Electric	2010	2008-Q4	$11,451	0.25	yes/no
Citigroup	4010	2009-Q1	$140,767	0.23	yes/yes	WeWork	6020	2021-Q4	$9,854	1.67	no/no
Freddie Mac	4020	2008-Q3	$139,024	0.12	yes/yes	Kinder Morgan	1010	2011-Q2	$9,331	2.24	no/no
Bank of America	4010	2008-Q4	$94,125	0.23	yes/yes	General Motors	2510	2008-Q4	$9,317	0.28	yes/yes
Bank of America	4010	2008-Q3	$82,771	0.33	yes/no	T-Mobile	5010	2013-Q2	$9,237	1.67	no/no
Morgan Stanley	4020	2008-Q4	$81,187	0.30	yes/yes	AT&T	5010	1984-Q1	$9,097	1.86	no/no
Wachovia	4010	2008-Q3	$81,156	0.27	yes/yes	General Electric	2010	2009-Q1	$8,544	0.18	yes/no
JPMorgan Chase	4010	2009-Q1	$76,000	0.24	yes/yes	Kinder Morgan	1010	2014-Q4	$8,327	1.28	no/no
Bank of America	4010	2009-Q2	$73,261	0.22	yes/yes	AT&T	5010	2002-Q4	$7, 528	1.14	no/no
Bank of America	4010	1998-Q4	$55,570	0.47	yes/no	Dell	4520	2021-Q4	$7,304	0.60	yes/no
Citigroup	4010	1998-Q4	$50,700	0.78	yes/no	Occidental Petroleum	1010	2020-Q1	$7,123	0.63	yes/no
JPMorgan Chase	4010	2008-Q3	$50,180	0.26	yes/no	Qwest	5010	2002-Q3	$6,417	0.49	yes/no

AIG	4030	2008-Q3	$47,395	0.32	yes/yes	Time Warner Cable	2540	2009-Q1	$6,339	0.78	yes/no
AIG	4030	2010-Q4	$44,447	1.21	yes/no	Lumen Technologies	5010	2017-Q4	$5,955	0.69	no/no
JPMorgan Chase	4010	2008-Q4	$42,539	0.18	yes/no	Raytheon	2010	2020-Q2	$5,920	1.34	no/no
Bear Stearns	4020	2008-Q1	$40,973	0.17	yes/yes	Mondelēz International	3020	2007-Q2	$5,752	2.22	no/no

Note: Guarantee amounts are in Q1 2010 US dollars. Group codes include 1010, Energy; 2010, Capital goods; 2030, Transportation; 2510, Automobiles and components; 2540, Media (old classification); 4010, Banks; 4020, Financial services; 4030, Insurance; 4520, Technology hardware and equipment; 5010, Telecommunication services; 5020, Media and entertainment (new classification); 5510, Utilities; 6060, Real estate management and development.

To compare the ex ante cost estimate here with ex post resolution costs for Continental Illinois, in nominal terms the Q3 1984 loss equaled $1.31 billion—not much larger than the $1.11 billion estimated losses that the FDIC reports on its failed banks list.[12] I can also compare the ex ante estimates of the debt guarantees with the ex post resolution costs reported by the FDIC for the spring 2023 bank failures. Because my approach uses end-of-quarter market values of equity and intraquarterly equity return volatility, it will likely not pick up corporations that fail before the end of the quarter, such as the banks that failed in spring 2023. I therefore provide estimates of the cost of guaranteeing Q4 2022 deposits for Silicon Valley Bank (SVB) and Signature Bank and Q1 2023 deposits for First Republic Bank. I also use market equity on the day they ceased operating, as well as equity return volatility estimated from the 63 days before their closure, assuming a risk-free rate of 4.8 percent in Q1 2023 and 5.1 percent in Q2 2023.

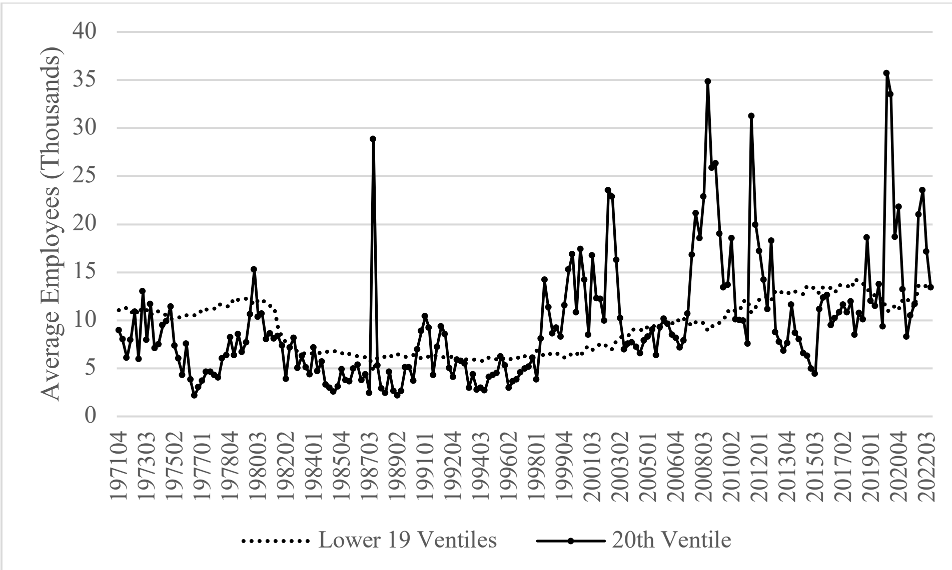
SVB and Signature Bank reported total deposits of $161.48 billion and $88.61 billion, respectively, in Q4 2022, when they filed their last call reports. First Republic reported $104.47 billion in total deposits by Q1 2023, when it filed its last call report. For SVB, when it was seized on March 10, 2023, its market value of equity equaled $6.28 billion. Signature Bank was seized on March 12, 2023, and its market value of equity equaled $4.03 billion. Finally, when First Republic was closed on May 1, 2023, its market value of equity equaled $653.63 million. For SVB, Signature, and First Republic, the ex ante cost of guaranteeing total deposits equaled $25.33 billion, $194 million, and $15.99 billion, respectively, while the FDIC's reported estimated ex post loss as of March 27, 2024, was $21.82 billion, $1.83 billion, and $16.66 billion, respectively. I discuss the relationship between estimated debt guarantees and employment next.

4.2 Employment and debt guarantees

Figure 4 depicts the average number of employees for corporations in the lowest 19 ventiles of estimated debt guarantees versus those in the 20th ventile. In ordinary times, the two series track each other, and the average for the 20th ventile is below the average across the lower 19 ventiles in 136 of 205 quarters. However, it is during periods of distress when the average for the 20th ventile spikes, suggesting that corporations, on average, are notably larger in terms of employees. To understand the differences numerically during the sample, note that the average number of employees equaled 8,750 for corporations in the lower 19 ventiles and 9,400 for corporations in the 20th ventile. However, during periods of higher volatility, such as Q4 1987, the tech crash of the early 2000s, the 2007–2009 financial crisis, and the COVID-19 pandemic, the averages for the 20th ventile spike well above the average for the lower 19 ventiles. This finding could explain why officials may take an interest in bailouts, even if it may not be the most effective solution.

[12] See the FDIC's BankFind Suite database at https://banks.data.fdic.gov/explore/failures.

FIGURE 4. Average number of employees for corporations in highest ventile and lower ventiles, Q4 1971–Q4 2022



Source: Author's estimates.

4.3 Discussion

Bailouts tend to receive considerable scrutiny, especially when the taxpayer is called on to foot the bill, which may arise because the corporations, especially financial ones, receiving bailouts may have political connections (see Faccio, Masulis, and McConnell 2006; Duchin and Sosyura 2012; Igan, Mishra, and Tressel 2012; Blau, Brough, and Thomas 2013; Vukovic 2021). However, officials may have at least two justifications for using bailouts. First, Ho and Singer (1982) suggest that debt guarantees, valued as in Merton (1977), in the case of Chrysler in 1979 arose to stem a surge of unemployed people who might not otherwise find employment elsewhere in the geographic area.[13] They also model the effect on the national output of the loan guarantee program. Under the assumption that agency and negotiation costs and congested labor markets could result in significant increases in unemployment, the model suggests that the loan guarantee program, by reducing or delaying default, could reduce or delay the surge of unemployment and associated reduction in national output. The tradeoff arises between keeping workers in an

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[13] See Rockoff (2022) for a discussion of Milton Friedman's view of the Chrysler loan guarantee. Friedman was not opposed to all debt guarantees, such as deposit insurance and the Continental Illinois case, because they might prevent a wider panic. However, in the case of Chrysler, Friedman viewed bankruptcy proceedings as a better option, while at the same time viewing employment programs, such as those during the Great Depression, beneficial. To put Chrysler's financial health for this episode in perspective, note that the quasi-market leverage ratio for Chrysler fell below 10 percent, but the estimated asset volatility never exceeded 15.1 percent between Q3 1979 and Q3 1982, and the estimated real guarantees never exceeded $33.39 million, much smaller than the $2.72 billion estimated for Continental Illinois in Q3 1984. Concerns about unemployment in 2008 factored into decisions to extend $17.4 billion in loan guarantees to Chrysler and General Motors (see Glass 2008); although Chrysler does not appear in the sample after Q4 1997 following its acquisition by Daimler-Benz, the nominal debt guarantee in Q4 2008 for General Motors equaled $9 billion and for Ford equaled $14.81 billion.

inefficient corporation employed, which would tend to reduce national output, and allowing the corporation to enter bankruptcy and have workers potentially unable to find employment elsewhere. The less quickly workers could be absorbed elsewhere, the more valuable the loan guarantee would be. In addition, the model also predicts that the more uncertainty that exists about the future, such as during some national emergencies, the more valuable the loan guarantee would be.

Second, debt guarantees may serve as an alternative privilege for corporations that might provide auxiliary state capacity during wars, pandemics, financial crises, or other national emergencies. To see how, Thompson (1974, 1979) examines the formulation of tax policy based on national defense principles.[14] Thompson (1974) shows that capital attracts foreign predation, and given the associated externality, taxing capital can be justified on the grounds that taxes pay for the protection to deter predation. Thompson (1979) argues that if government policies during national emergencies, such as a war, cause corporations in certain industries that may be called on to provide auxiliary state capacity to underinvest, then certain tariffs or subsidies may be used to offset the underinvestment arising from the initial government policy. Although debt guarantees are not included among the corrective measures discussed by Thompson (1974, 1979), the government may use such guarantees to ensure the existence of certain corporations with which it has transactional relationships that provide state capacity during national emergencies.

For instance, banks have helped finance war efforts by holding Treasury securities (see Bordo, Redish, and Rockoff 2015); the government, in turn, has provided backstops during financial crises in recent decades. Airlines have provided auxiliary capacity to transport troops (see Hendrickson 2019).[15] Following the events of September 11, 2001, Congress passed the Air Transportation Safety and System Stabilization Act (Pub. L. No. 107-42, 115 Stat. 230), which allowed airlines to receive $5 billion in cash and $10 billion in loan guarantees. During COVID-19, Congress granted support of up to $25 billion in loans and loan guarantees to passenger airlines, $4 billion to cargo airlines, and $17 billion to other corporations deemed important for national security in section 4003 of the Coronavirus Aid, Relief, and Economic Security (CARES) Act of 2020 (Pub. L. 116-136, 134 Stat. 281).[16] That said, airline assistance seems to have focused on loans rather than guarantees. Lastly, automobile manufacturers have provided support to the government during national emergencies while also receiving debt guarantees when they experience distress, as with Chrysler and General Motors.

The results suggest that estimated debt guarantees for individual corporations and the aggregate can be substantial during periods of widespread distress, while corporation leverage and asset volatility can contribute to higher debt guarantees. A key focus of bank supervision in the United States has been to limit asset volatility while regulation has long relied on minimum capital requirements to limit bank leverage. With the establishment of the Federal Deposit Insurance Corporation in 1933, minimum capital requirements have relied on ratios, initially the

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[14] See also Hendrickson (2019), who shows how the Jones Act works like a subsidy to protect the merchant marines as a form of compensation in exchange for their contributing to greater naval capacity during a war.

[15] For a brief history of airline involvement during World War II, see van der Linden (2020). For a brief history of Pan Am's auxiliary efforts during the Vietnam War, see Pan Am Historical Foundation's online exhibit "Pan Am and Vietnam," https://www.panam.org/the-jet-age/737-pan-am-vietnam.

[16] For details, see the website of the US Treasury at https://home.treasury.gov/policy-issues/coronavirus/assistance-for-industry/loans-to-air-carriers-eligible-businesses-and-national-security-businesses.

capital-to-deposit ratio and later the capital-to-asset ratio.[17] For several decades thereafter, known as the Quiet Period, the United States had no banking crises, although that was more likely due to circumstance than design (see Bordo, Redish, and Rockoff 2015). That situation changed after the Latin American Debt Crisis of 1982 (see Kapstein 1991, 1994). Congress sought to increase bank capital as a so-called price for increasing quotas at the International Monetary Fund to assist the governments borrowing from banks in the United States through the International Lending Supervision Act of 1983 (Pub. L. No. 98-181, 97 Stat. 1278). As such, the law gave rise to regulatory initiatives that resulted in the Basel Capital Adequacy Standards, which sought to increase bank capital requirements multilaterally (see Kapstein 1991, 1994; Barth and Miller 2018b).

In recent decades, banks, securities firms, and insurance companies have been subjected to risk-based capital requirements, whereby the minimum amount of capital required varies with the type of assets held (see Herring and Schuermann 2005). Some recent studies show how the risk-based capital requirement guidelines have made capital regulation increasingly complex (see Herring 2016, 2018; Barth and Miller 2018b). Other studies also show that risk-based capital requirements can give rise to gaming of the regulatory capital requirements and can alter corporate balance sheets and activities (see Acharya, Schnabl, and Suarez 2013; Vallascas and Hagendorff 2013; Mariathasan and Merrouche 2014; Miller 2018; Merrill, Nadauld, and Strahan 2019; Efing 2020; Miller and Hoarty 2021).

Admati and Hellwig (2024) suggest a simpler alternative by setting the minimum equity-to-asset ratio at 30 percent, but allowing the ratio to fall within the 20–30 percent range; Barth and Miller (2018a) find more than 56 percent of the assumption-based cases where the optimal capital ratio ranges from 20 percent to well over 30 percent. Black (1975) suggests using a simple capital rule for banks whereby each dollar of deposits (or perhaps today's short-term debt funding) must be funded with at least one dollar of equity or long-term debt. As debt guarantees may exist in other industries, one option for limiting taxpayer exposure could be simple minimum leverage restrictions (see, for example, Cochrane 2020). Whether justified on the grounds of concerns about unemployment or the closure of corporations deemed vital during national emergencies, such restrictions can turn debt guarantees into so-called farther-from-the-money options, thereby reducing the likelihood and potential amount of a payout, depending on the minimum capital ratio to limit leverage.

5. Conclusions

The policy debate surrounding debt guarantees focuses on financial corporations. I find banks and other financial corporations have the largest estimated aggregate marked-to-market cost of guaranteeing debt, but corporations in other industries can have sizable estimates. The highest aggregate cost of guaranteeing debt from Q1 1974 to Q4 2022 occurred during the 2007–2009 financial crisis. The next highest aggregate cost of guaranteeing debt appeared briefly in Q1 2020 during the early stages of the COVID-19 pandemic and arose more with nonfinancial corporations. The estimated cost of guaranteeing debt also spiked in Q4 1998, after the Russian debt default. A common criticism of debt guarantees arises from perceived (if not realized) harm to taxpayers, even as debt guarantees may represent a form of protection against higher

[17] See Federal Deposit Insurance Corporation (1984). Before the establishment of the Federal Deposit Insurance Corporation, minimum capital requirements were set in dollar amounts based on the size of the town in which the bank was located (see White 1983).

unemployment from large, failed corporations or a privilege extended to corporations in exchange for auxiliary support to the state during national emergencies. Recent corporate finance research finds debt financing is better suited for tangible capital formation, while equity is better suited for intangible investments in innovative industries (see Brown, Martinsson, and Petersen 2017). That aside, leverage restrictions on large corporations relying on extensive debt financing provide one way to limit the realization of debt guarantees.

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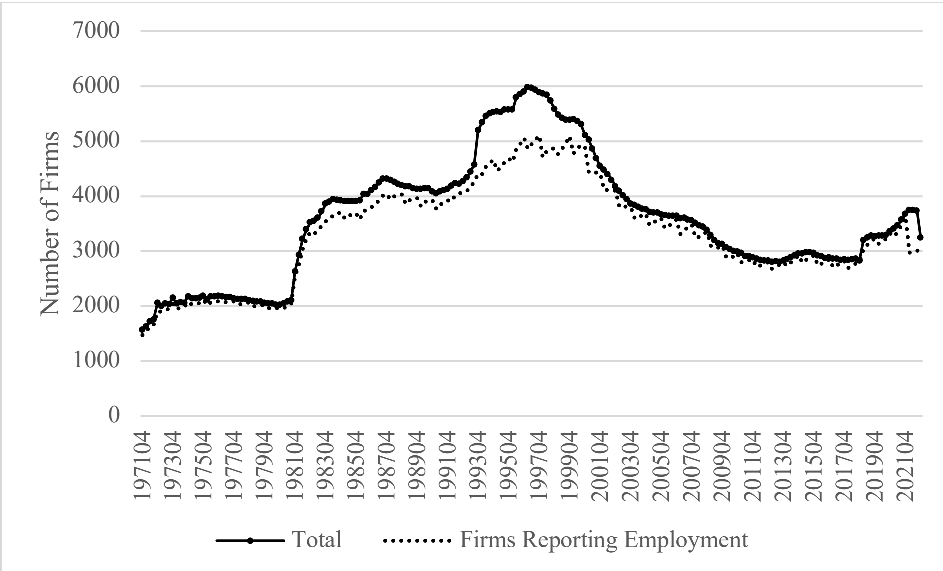
Appendix

TABLE A1. Variable construction

Variable Name	Transformation Applied to Raw Series
End-of-Quarter Merton (1977) Put Option Prices	Using equations (1) and (3), solve for the unobservable market value of assets and its volatility after substituting in values for the observable variables to reach the numerical solutions. For the volatility input, use the daily stock price data from the Center for Research in Security Prices (CRSP) database, available at https://wrds-www.wharton.upenn.edu/, to calculate the daily log returns on the daily market value of equity, measured as the product of the absolute value of the stock price and shares outstanding, abs(PRC)*SHROUT, which also serves as the market value of equity input. The data from Q4 1971 to Q4 2020 were downloaded on November 10, 2021, and the data from Q1 2021 to Q4 2022 were downloaded on March 12, 2023. Then estimate the quarterly standard deviation of equity returns for each corporation. To annualize the historical equity return volatility input, multiply that by the square root of the number of intraquarterly trading days times four. Merge the quarterly standard deviations of equity returns and the end-of-quarter market value of equity for each corporation with the Compustat quarterly financial data, which were downloaded on April 10, 2023. For the debt input for nonbank corporations, use the sum of item 45, "Debt in Current Liabilities," and item 51, "Long-Term Debt-Total" for the Ronn and Verma (1986) approach. For the debt input for banks, use total deposits. Then replace missing values with zeroes, and select only corporations with less than 100 percent equity. For the risk-free interest rate input, use the quarterly rate of return on the 90-day US Treasuries from CRSP, which, together with the Consumer Price Index, was downloaded on November 24, 2023. The time to maturity equals one. To adjust for dividends, subtract item 24, "Dividends/Preferred/Preference," from item 89, "Cash Dividends," and replace it with zero if missing or negative. To adjust for dividends and buybacks, add to the dividend measure share buybacks by subtracting item 71, "Preferred/Preference Stock/Redeemable," from item 93, "Purchase of Common and Preferred Stock," and replace it with zero if missing or negative. Use the inputs mentioned earlier to compute the put option values. Finally, to transform the variables in real terms, use the Consumer Price Index from CRSP.

Sources: Merton 1977; Ronn and Verma 1986.

FIGURE A1. Number of corporations in the sample, Q4 1971–Q4 2022



Source: Author's estimates.